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News

Budget Boosts Overall Research But Cuts NOAA and USGS Funds

Science in general, and physical sciences in particular, show growth far above projected inflation in President Ronald Reagan's fiscal 1984 budget proposal. Total funding requested for all federal research and development, including facilities, is \$47 billion, up 17.2% over fiscal 1983, jumping hurdles over the 5% projected inflation rate. Defense R&D is slated to soar 29% to \$30.5 billion, while nondefense R&D would rise 0.4% to \$16.7 billion. Table 1 shows the proposed research and development budgets by major departments and agencies.

Basic research in fiscal 1984 would be increased 9.9% over the fiscal 1983 level (Table 2). The growth rate of basic research in agencies primarily supporting the physical sciences and engineering sciences is 5 times greater than in those primarily supporting the life sciences.

Of the four nondefense agencies most directly involved in geophysical research, the National Science Foundation (NSF) fared the best with an 18.1% increase; the National Aeronautics and Space Administration (NASA) budget rose 3.9%; and the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) budgets fell 7% and 10%, respec-

President's budget request and, if Congress desires, to alter it. Eas will track the budget process through Congressional approval.

In the following analysis, numbers may not total because of rounding.

The fiscal 1984 budget request for NSF is \$1.292 billion, up 18.1% from fiscal 1983. Three major functions compose the NSF budget; research and related activities; scientific and engineering education activities; and special foreign currency appropriations. Research and related activities, accounting for more than 95% of the total NSF budget, got a 17.5% increase in the Reagan budget proposal. Science and engineering education got a 30% boost to \$39 million. In the special foreign currency category, the budget allocates \$2.6 million—roughly \$0.5 million less than the obligations for the current fiscal year; however, \$918,000 of the \$3.12 million that was budgeted in fiscal 1985 will be carried forward for fiscal 1984.

Under the budget proposal, the Directorate Ocean Sciences (AAEO) would receive \$334.9 of this increase, however, can be attributed to ciences got a 9.8% increase to \$89.1 million;

using the Glomar Challenger. A recently formed ad hoc advisory group on crustal studies, chaired by AGU President-elect Charles Drake, met as Eos went to press to r view crustal research and to examine the long-term needs and priorities for ocean drilling in this light. Their recommendation could alter program proposals that NSF will present to the House Appropriations Com-mittee on February 15. Eos will have more details in a few weeks.

continuation of the Deep Sea Drilling Project

ic chemistry and aeronomy program will receive \$2.75 million (up 29.7%), while atmo-

spheric technology will get \$7.51 million, an increase of 25.7%. Experimental meteorology is due to receive a 38.5% hike to \$5.4 million.

Experimental and theoretical geophysics

Other major increases go to the experimental

throughout the division would permit year-

Growth in the ocean sciences division will

expand support for crustal studies, especially research that relates to the continental crust

in the earth science division. The 59.4% in-

crease in ocean drilling programs assumes a

10.8

3017 3347 3864 10.9 15.4 28.1

Percent Change

84/83 84/82

structure of continental crust.

Millions of Dollars

2422

Source: Office of Management and Budget and Office of Science and Technology Policy.

FY 82 FY 83 FY 84 83/82

6025 6619

2678 2755

Polar Programs

All but one of NSF's polar programs show growth beyond inflation. Claciology pro-grams, within the Arctic research division of AAEO, would get a hefty 77.8% increase to \$2 million. The Arctic oceanography program, however, would receive only 2.1% more money (to \$1.2 million) than it did in

fiscal 1983 if the budget is passed as it stands.
The fiscal 1984 budget request for the U.S.
Antarctic Program (which is separate from
AAEO) is \$102.1 million, an increase of \$18.9 million above the fiscal 1983 plan. Most of the increase goes for two capital investments: \$5.8 million to replace a large vehicle mainte-nance facility destroyed by fire in December 1981 and \$5 million to initiate a service life extension program on the two oldest LC-130 ski-equipped Hercules aircraft. In addition, Antarctic oceanography research will be boosted 14.8% and Antarctic glaciology re-

search will be increased by 14.3%. Compared to other directorates, AAEO and the U.S. Antarctic Program did reasonably well. The Directorate for Mathematical and Physical Sciences purse totals \$364.3 mil lion (up 21.5% from fiscal 1983); the Directorate for Biological, Behavioral, and Social Sciences is slated to receive \$223.6 million (up 17.5%); and the Directorate for Scientific, Technological, and International Affairs (better known as STIA) will receive \$36.8 million,

Engineering

The Directorate for Engineering (allocated \$123 million, up 22%) includes the civil and environmental engineering programs, which encompass the activities of some AGU members. Within the civil and environmental engineering category, geotechnical engineering is slated for a 21.2% increase to \$4 million; structural mechanics will get a 27.6% increase to \$3.7 million; hydraulics, hydrology, and water resources engineering will receive an 18.9% increase to \$4.4 million; environmen tal and water quality engineering will get a 17.9% increase to \$3.5 million; and earthquake hazard mitigation will receive a 9.8% increase to \$19 million.

NOAA Funding Drops 10%

A close look at the President's fiscal 1984. budget request for NOAA reveals an overall program level of \$843.2 million; \$799.8 mil-418 426 425 438 lion of requested funds plus \$43.4 million in transfers. The \$799.8 million request represents an approximate 10% cut in funding— not including inflation—from the fiscal 1983

Of the \$799.8 million requested, \$784 mil-

Budget (cont. on p. 66)

NASA Unit Sets Ambitious Course

After two decades of spectacular successes, planetary exploration has fallen upon hard times. It has been five years since a new spacecraft was launched toward the planets. and NASA has under current development only one planetary mission—Galileo, which will orbit Jupiter and probe its atmosphere in 1988. The intellectual challenge of understanding the planets and their common origin and evolution has not, of course, declined, and a great deal of exciting work is being ac-complished using data (and samples) from past messions. But planetologists fear the demise of their discipline within a few years if momentum cannot be restored to NASA's

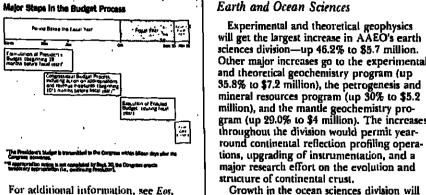
program of planetary exploration. One response to this crisis was the estab-lishment in 1980 of a high-level scientific advisory committee to chart a course of planetary missions through the end of this century that would recapture the excitement of the 1960's and 1970's at a price consistent with the current constrained NASA budget. The Solar System Exploration Committee (SSEC), a subcommittee of the NASA Advisory Council, was originally chaired by John Naugle, then NASA Chief Scientist. In 1982 he was succeeded by Noel Hinners, then Director of the National Air and Space Museum and now Director of the NASA Goddard Space Flight Center (and also president of the AGU Planetology Section). For 1983, the chairmanship of the SSEC passes to David Morrison, Professor of Astronomy at the University of Hawaii and a former NASA Acting Deputy Associate Administrator for Space Science.

As it enters the final year of its charter, the SSEC is putting the finishing touches on a core program for planetary exploration through the year 2000. Acutely conscious of the fiscal constraints being imposed on space science today, the Committee has limited itself in this core program to missions with high scientific return at modest costs. In general, the committee will achieve these savings by avoiding the challenge of new technolo-gies, such as those required for a Mars mo-bile lander or a comet sample return; it will rely instead on the proven capabilities of flybys, orbiters, and atmospheric probes. The committee will aim for further savings by a close and carefully planned spacing of missions to realize maximum inheritance and common operations. Although the written report is not complete, it seems clear that in spite of these constraints an exciting series of missions is being proposed. If the SSEC core program is put into effect, we should see by the year 1990 launches (in addition to Galileo) of a Venus Radar Mapper, a Mars Geochemical/Climatology Orbiter, and a rendezvous mission to the short-period Comet HMP. Under development would be additional missions to the moon, Titan, and a number of asteroids. The SSEC claims that these results can be achieved at a total cost (in current dollars) of \$300 million a year, only one third the budgetary levels of either the mid-1960's or the mid-1970's.

The first mission in the SSEC core pro gram is a Venus Radar Mapper (VRM), designed to produce a topographic map with better than 1 km resolution—comparable to the achievements of the first Mars orbiter, which revolutionized our understanding of the geological history of that planet. VRM, one of four initiatives in the proposed fiscal 1984 NASA budget, is a scaled-down version of VOIR (Venus Orbital Imaging Radar), a mission deleted from the NASA budget in FY 82 by the Reagan administration. In a sense, VRM is archetypical of the SSEC missions, making maximum use of spare hardware and inherited designs, and carrying a modest science payload focused on specific, high-priori-

During 1985 the SSEC will release its report on the core program and will go on to consider the more technologically challenging—and more expensive—missions that were excluded from its initial recommendations. Also, this group will be trying to make sure that as many people as possible are hearing its basic message that planetary exploration is not finished, and that numerous exciting missions are within our capability at relatively modest cost. If this message strikes a resonant chord among Washington decision makers, the United States will maintain its lead in netology through the 1990's.

This news item was contributed by David Morrison of the Institute for Astronomy at the University



For additional information, see Eos, February 9, 1982, p. 148. (Figure from The United States Budget in Brief: Fiscal Year

Agencies Supporting Primarily Life

Agencies Supporting Primarily Physi-

Astronomical and Atmospheric Sciences

45.7%) for solar system astronomy and \$9.8

million (up 46.5%) for astronomical instru-

mentation and development. The National

crease of 24%) and \$315,000 from NASA,

ceive \$21.9 million, up 17.5%. The Nationa

geted for \$20.6 million (an increase of 28.3%); the Sacramento Peak Observatory

Radio Astronomy Observatory has been bud-

uld receive \$2.6 million from NSF (up

of Defense. The emphasis on astronomy will

allow for the implementation of the most important recommendations of the Astronomy

of Sciences (Eas. May 18, 1982, p. 506).

Among the committee's priorities are im-

proved instrumentation at universities and

national centers, and feasibility and design

studies on the Very Long Baseline Array. Within AAEO's atmospheric sciences divi-sion, the Global Atmospheric Research Pro-

gram (GARP) has been marked for a 5% cut

(to \$4.8 million). Other programs budgeted for at least a 20% increase are atmospheric

chemistry, climate dynamics, meteorology,

and solar terrestrial research. The biggest in-

rvey Committee of the National Academy

23.8%) and \$415,000 from the Department

Astronomy and Ionospheric Center has been budgeted for \$6.5 million from NSF (an in-

while the Kitt Peak National and Cerro-Tololo Inter-American observatories would re-

division budget include \$2.2 million (up

Highlights of AAEO's astronomical sciences

cal Sciences & Engineering

Total Basic Research

Sciences

TABLE 2. Conduct of Basic Research

Congress now has the task of reviewing the

NSF Budget Boosted

for Astronomical, Atmospheric, Earth, and million, a 21.3% hike over fiscal 1983. Some the inclusion of the ocean drilling programs in the directorate; the programs were previously under the aegis of the NSF director. Within the directorate, the astronomical sciences division got a 25.9% increase to \$79.3 million; the atmospheric sciences division got a 20.7% boost to \$90.6 million; earth sciences got a 23.5% increase to \$42.1 million; ocean and the Arctic research program got a 19% increase to \$7.5 million. Funding for ocean

crease—41.4%—goes to scientific computing at the National Center for Atmospheric Redrilling programs is scheduled to grow 59.4% to \$26.3 million. search (NCAR). NCAR is slated to get \$40.6 million, up 23.8%. At NCAR, the atmospher-TABLE 1. Conduct of Research and Development by Major Departments and Agencies

Department or Agency	Obligations			Outlays		
	1982 Actual	1983 Estimate	1984 Estimate	1982 Actual	1983 Estimate	1984 Estituate
Defense-military						
functions	20,576	23,179	29,882	18,201	21,847	26,844
Energy related activi-		-				
ties	4,758	4,712	4,713	4,974	5,012	4,911
Health and Human						
Services	3,935	4,316	4,416	3,978	4,262	4,339
(National Institutes of	2,002	-,	-•-	•		
Health)	(3,432)	(3,771)	(3,842)	(3,438)	(3,737)	(3,808)
National Aeronautics	(01101)	(0)/	\-		• • •	•
and Space Adminis-						
tration	3,084	2,506	2.473	3,220	2,386	2,421
National Science	0,001	4,000		-•-	-	
Foundation	975	1,060	1.240	1,014	1,002	1,137
Agriculture	798	850	849	808	839	848
Transportation	309	393	519	349	376	451
Interior	381	373	329	392	411	348
Commerce	290	312	227	285	315	249
Environmental Pro-	600	0.4				
tection Agency	335	241	208	336	295	250
Nuclear Regulatory	333	471				
Commission	221	210	200	209	210	200
Veterans Administra-	221	210	200			
tion	140	165	163	138	157	156
Agency for Interna-	140	100	100			
tional Development	188	152	161	179	200	152
All other	165	391	418	426	425	433
Total	388 36.354	38,860	45,796	34,509	37,735	42,741

36,354 Table courtesy of Office of Management and Budget, In millions of dollars, Numbers may not

Includes the Departments of Education, Justice, Labor, Housing and Urban Development and Treasury, the Tennessee Valley Authority, the Smithsonian Institution, the Corps of Engineers, and the Federal Emergency Management Agency.

Budget (cont. from p. 65)

lion would be allocated to the heart of the NOAA budget: Operations, Research, and Facilities; coastal zone management, previou ly a separate appropriation item, has been transferred into that category. Separate appropriations for miscellaneous 'fishing funds'

account for the remaining \$15.8 million. The Operations, Research, and Facilities category is divided into five activities (Table 3), three of which are detailed in the following paragraphs.

Ocean and Coastal Programs

NOAA proposes to eliminate the Sea Grant subactivity. Within the nonliving marine resources subactivity, the polymetallic stillides program would be terminated and funds for deep seabed mining and ocean thermal energy conversion (OTEC) research would be reduced. The ocean research subactivity budget proposes an additional \$2.5 million is proposed to expand the ocean climate research program. Ocean research programs slated to end are the undersea research program, region-specific ocean pollution research, the Great Lakes research program (and with it, the closing of the Great Lakes Environmental Research Laboratory), and the Chesapeake Bay studies.

The budget for the ocean services subactivity requests an increase to cover the cost of producing publications on tides and currents; the entire cost of this program will be funded from appropriations and all receipts from the sale of the publications will be deposited to the Treasury Department. Decreases are proposed for the marine boundary program, for the marine current data collection program, and for the development of new technol in support of other ocean programs.

Within the coastal zone management subactivity, monies are requested to complete the phase out of the program. Decreases would eliminate the states' assistance program and would reduce funding to the estuarine sanc-

Growth in the funding for the mapping, charting, and geodesy subactivity would help purchase additional receivers to use the Delense Department global positioning system. Funds also are requested for equipment to use interferometry techniques that aim to improve the efficiency of the geodetic reference system operations. The budget reduces technical support to state geodesy programs and eliminates plans for a geodetic survey of

Almospheric Programs

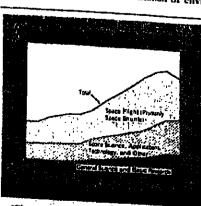
NOAA's atmospheric programs support weather prediction (including that of the Na-tional Weather Service), weather warning services, and associated research. Addition funds are requested to continue the NEX-RAD program. Cuts within the public warning and forecasting services would close the southern region headquarters; consolidate the Alaska and Pacific headquarters; and eliminate regional hydrologist offices. The budget would shrink the fire weather program and terminate the agricultural weather, fruit frost, and aviation area forecast pro-

Increases would go to the atmospheric and hydrological research subactivity for research to improve prediction of severe weather and for investigations into seasonal climate forecasting using improved circulation theories.

Decreases would go to weather-related systems development and hydrological research, to state-specific weather modification activities, and to certain Global Atmospheric Research Programs (GARP) grants and projects. Proposed for elimination are all of the research and some of the services at the Solar Environmental Laboratory.

Satellite and Environmental Data

Satellite and environmental data information services is the only activity within NOAA Operations, Research, and Facilities that, as a whole, shows growth beyond inflation in the budget request. Most of this growth stems from transfer's from NASA of LANDS Are is from NASA of LANDSAT and high-resolution scanner (thematic mapper) operations. Also covered under this category are programs associated with the procurement and operation of the polar and geostationary weather satellites and the collection, archiving, and dissemination of envi-



(Figure from The United States Budget in Brief: Fiscal Year 1984.)

ronmental data and information.

The programs of the old National Environmental Satellite Service (NESS) and the old Environmental Data and Information Service (EDIS) are funded under this activity. In the satellite services subactivity, the budget allots the geostationary satellite additional funds so that its temperature and moisture sounding capability can be converted from a research prototype to an operational system. Under satellite services, the budget proposes to save money by consolidating satellite field service stations with weather service forecast offices in the same locale. This subactivity, which covers the procurement of satellite spacecraft, their launch, and associated ground systems. would receive additional money to store and check the LANDSAT D' satellite. The budget requests modifications of polar satellites that would allow their positioning in an orbit closer to noon to provide more useful informa-tion to the National Weather Service operational model. A decrease has been requested for a one-satellite polar-orbitng system.

Within the data and information services subactivity, the budget would reduce the dimate data base effort, eliminate centralized NOAA publication functions, and end direct funding for the NOAA core library system.

Of the 22 vessels that NOAA currently operates, 10 are proposed for deactivation. Two of these—the Surveyor and the Ferrel—are research vessels; the rest are fisheries vessels. Sea time is be reduced for other research ves-

NOAA anticipates a 13% reduction in staff in fiscal 1984; although some of this reduction will be through aurition, some may be through reduction in force (RIF).

USGS Funding Down

USGS funds will shrink 7% to \$365.5 million under the President's budget proposal. (The fiscal 1983 appropriation enacted to date is \$369.8 million; additions of roughly \$23.4 million in net transfers and requested supplementals are anticipated.) Some of the decrease for fiscal 1984 is owed to the transfer of conservation of land and minerals activities to the Minerals Management Service.

Geologic and Mineral Resources

The largest USGS activity, Geologic and Mineral Resource Surveys, is budgeted for a 13.7% drop to \$141.9 million. The next largest, Water Resources Investigations, has been allocated \$112.1 million (down \$7.8 million). The National Mapping Program would re-ceive \$77.9 million (down 11.9%) plus \$6 million (up 50%) for digital cartography; al-though part of the the National Mapping Program, digital cartography activities have en proposed as an appropriation separate from the larger activity.

Geologic and Mineral Resource Surveys is divided into five subactivities. Within the mineral resource surveys subactivity, the budget gives \$9.3 million (an increase of nearly 60%) for the strategic and critical minerals program to enhance researching the mineral potential of the eastern and midcontinent states. Within the geologic hazards subactivity the budget would cut the earthquake hazard reduction program (down 14.5% to \$29.5 illion), volcanic hazards (down 92.1% to \$7.4 million), ground failure and construction hazards (down 25% to \$2.1 million), and reactor hazards research (down 46.9% to \$1.7

Within the third subactivity, land resource surveys, the budget halves funds for the climate changes program to \$0.5 million. Although the land resource data application program is being eliminated, USGS says the activities will be conducted throughout the geologic research part of the agency. Within the energy geologic surveys subactivity, the shale oil investigations program would be cut most deeply: down one third to \$0.6 million. Also scheduled for cuts are coal investigations (down 32.4% to \$9.8 million), uranium/thorium investigations (clown 27.3% to \$3.2 million), and geothermal investigations (down 27.4% to \$5.3 million). The fifth subactivity, offshore geologic surveys, would m fiscal 1983 budget of \$13.7 million for the offshore geologic framework program.

Water Resources

Under the Water Resources Investigations activity, funds for the toxic waste-groundwater contamination program would rise 16.4% ter contamination program would rise 10.4% to \$7.1 million, while acid rain program funding would increase to \$3.1 million (up 19.2%). Under the energy hydrology subactivity, funding for coal hydrology would be chopped 71.4% to \$2 million, and funding for oil shale hydrology would done 78.0% to for oil shale hydrology would drop 76.9% to \$0.8 million. The program for analyses of regional aquifer systems would drop 8.5% to \$14.0 million, while the environmental affairs program would fall by one fifth to \$0.8 million. The budget eliminates the flood hazard analysis program and, although the data base for the water resources scientific information. center will be maintained, the center's fundcenter will be maintained, the center's fund-ing has been wiped out. Programs suggested for level funding include national water data exchange, coordination of national water data activities, tore program hydrologic research improved instrumentation, water resources assessment, and coal hydrology (within the

TABLE 3. Appropriations for NOAA Operations, Research, and Englisher

Program	1984 Base ³	1984 estimate	difference
Ocean and coastal programs	148,745	117,125	
Nonliving marine resources	3,032	1,761	-21.3
Ocean research	35,434	23,452	11.9
Ocean services	15,764	13,237	-33.8
Sea Grant	35,000	0	-16.0
Coastal zone management	14.226	6,056	~100.0
Mapping, charting, and geodesy programs	15.289	72.619	-57.4
Marine fishery resource programs	146, 191	92,411	+60,3
Information collection and analyses	75,049	55,752	-36.9
Conservation and management operations	55,506	33,166	-25.7
State and industry programs	15,936	3.226	-39.7
Atmospheric programs	321,263	309, 197	-79.R
Public warning and forecasting services	272,221	264.936	-3.7
Atmospheric and hydrologic research	19.042	11,561	-2.7
Satellite and environmental data and informa-			-9.1
tion services	198,756	212,953	_
Satellite services	66.617	73,279	+7.1
Satellite systems	106,500	117,361	+ 10.0
Data and information services	25,639	22,313	+ 10.2
Program support	115,813		- 13.0
Executive direction and administration	54,150	95,353 11,748	- 17.7
Marine services	57,483	16,525	- 17.4
Aircraft services	4,180	1.080	- 19.1 -2.4

11984 base reflects fiscal 1983 operations, research, and facilities funding levels plus adjusments to base for such items as the proposed 1983 program supplemental, anticipated 1983 pay increase supplemental, and annualization of LANDSA Loperations and reflects transfers such a those for coastal zone management and the coastal energy impact fund.

subactivity called national water data system: federal-state cooperative program).

The only initiative within the USGS budget request for fiscal 1984 falls within the purview of the National Mapping Program. With a \$1 million budget, the new federal mineral land information program aims to provide a computerized data base to answer questions on federal land ownership and mineral occurrence data.

Rounding out the USGS budget are the requested appropriations for facilities (\$13.2 million, which is no change from the current fiscal year) and for general administration (pared \$1.3 million to \$14.2 million). The USGS expects that the number of full-timeequivalent staff members will drop through attrition nearly 5% to 7,587 in fiscal 1984.

NASA Nudges Inflation

Monies requested for NASA in the fiscal 1984 budget total \$7.1 billion. This increase of \$267.2 million or 3.9% over fiscal 1983 means that NASA only edges up to the projected 5% inflation rate. (Growth within NASA's programs will be higher, though, he-cause most of the funds for LANDSAT, pre-viously operated by NASA, now are included in the NOAA budget.) Research and development, which accounts for roughly 80% of NASA's total budget, would increase 3% to \$5.7 billion; the request for construction of facilities would increase 54.4% to \$150.5 million, while research and program manage-

ment would climb 4% to \$1.2 billion. This is a constrained budget consistent with the serious fiscal and budgetary situation facing the nation, commented NASA Administrator James M. Beggs. 'Nevertheless, it reflects the President's renewed commitment to a strong national space and aeronautics program as outlined in his two important policy statements on space and acronautics last

NASA's research and development falls into five categories: space transportation systems, space science and applications, technology utilization, aeronautics and space technology, and tracking and data acquisition Roughly 60% of the research and development budget would go to space transporta-tion systems, including production and oper-ation of the space shuttle. The allotted funds total nearly \$3.5 billion, a 2.8% decrease from fiscal 1983. The majority of the money was cut from space transportation capability development. NASA administrators say that there are no plans for a fifth shuttle orbiter.
However, included in the budget request is hardware development for the Tethered Satellite System, one of four new starts in the NASA budget. A cooperative U.S.-Italian project, the new system would permit experints in space at distances up to 100 km from the shuttle orbiter.

Space Science and Applications

Space science and applications is the second largest of NASA's R&D programs and contains most of NASA programs tied directly to geophysical research. Programs in physics and astronomy would receive \$514.6 million, an increase of 16.7% from fiscal 1983; life sciences would get \$59 million (up 5.9%); solid earth observations would decrease to \$74.4

million (down 43.7%) with the transfer of LANDSAT operations to NOAA; environmental observations would increase to \$168 million (up 3.9%); materials processing in space would lose \$400,000 (1.8%); communications would decrease to \$21.1 million (down 34.9%); and information systems would receive \$8.9 million (up 18.7%). The communications program includes startup of design and development for the Advanced Communications Technology Satellite (ACTS) project. ACTS, budgeted for \$5 million in fiscal 1984 (plus \$20 million carried forward from fiscal 1983), aims to develop and perform in-flight tests of the high-risk technology needed to ensure continued United States preeminence in the field of satellite communications, according to NASA Admin istrator Beggs, Costs for ACTS will be shared

Programs in planetary exploration, also within space science and applications, would increase 10.2% to \$205.4 million in the Reagan budget proposal. The Venus Radar Map-per (VRM) Mission, a new start in this categoy, would receive \$29 million. VRM replaces the Venus Orbiting Imaging Radar (VOIR) mission that was authorized by Congress in fiscal 1982. Total costs for VRM are expected to be half the estimated costs of VOIR, Development of the Galileo mission would be allocated \$79.5 million, a decrease of 13.2% from the current fiscal year and research and analysis would decline 9.5% to \$45.5 million. Mission operations and data analysis would increase 12.7% to \$43.4 million, while the International Solar Polar Mission would get \$8 million, up from \$6 million.

Within environmental observations programs, funds for the shuttle and Spacelab payload development would jump 105.4% to \$7.6 million and funding for upper atmosphere research satellite experiments and nission definition would grow by 42.9% to \$20 million. The largest decreases were proposed to the operational satellite improvement program (down 90% to \$600,000) and to the earth radiation budget experiment (down 35.43; to \$15.5 million).

Aeronautics and Space Technology

Aeronautics resenrch and space technology funded at \$438.5 million in fiscal 1984, up 8.8%) would have as its centerplece the Nu merical Aerodynamic Simulation (NAS) capa bility project. NAS, a large computer syste would have 'a major impact on aircraft design methods, improving accuracy and reliability while at the same time, cutting down on long and expensive wind tunnel and flight testing. according to Beggs. NAS, one of the four NASA initiatives, is budgeted for in the fiscal 1984 budget.

Of the remaining two categories within NASA research and development, funds for tracking and data acquisition would increase 40.3% to \$700.2 million and technology utilization would drop 55.6% to \$4 million.
Of the funds allocated for construction of facilities, the largest amounts would go to the Lewis Research Center (\$10.6 million), Langley Research Center (\$9.5 million), and the Jet Propulsion Laboratory (\$4.5 million) In addition, the budget allocates \$41.5 million

lion to the various space shuttle facilities and

\$12 million to various space shuttle payload

AGU to Revise Journal Index Terms

AGU is revising its set of indexing terms. If you have suggestions or comments, please contact the appropriate Journals Board member, AGU Journal Editor, or Associate Editor by Rebruary 23, 1983, AGU proposes to coordinate its index with a revision of the AIP/APS-PACS index scheme (Phys. Rev. Lett., 48, 1, 1989) 1982) (see Eas, February 8, 1983).

Solitary Waves As Aviation Hazard

Scientists at the Australian National University in Canberra have found that wind shear produced by solitary atmospheric waves is a potentially serious hazard to aircraft operating at low altitudes. In recent years a significant number of aircraft accidents have been attributed to a sudden, unexpected encounter with low-level wind shear during the landing or takeoff stage. In many cases it has been possible to associate the hazardous shear with one of a variety of well known meteorological wind shear conditions including intense thunderstorm down drafts, down-draftproduced density currents, cold frontal systems, and sea breezes. These sources are easily recognized and are usually predictable in the airport environment. In some instances, however, the identity of the wind shear source has been uncertain. Studies of the properties of large amplitude solitary waves in the boundary layer have shown that they produce intense, transient, horizontal and vertical wind shears which are compara ble with the well known types of shear. Solitary wave activity may therefore account for some hitherto unexplained aircraft accidents.

Until recently, solitary waves were regarded as a curious but relatively unimportant dynamical phenomenon. It is now recognized that these waves are exceptionally stable entities that play an important role in the dynamics of geophysical fluid systems. Internal soli-

The Weekly Newspaper of Geophysics

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Cover. Approaching low-level roll cloud

formation produced by a solitary wave propagating in a maritime inversion toard the southwest over saline coastal flats near Burketown, Queensland, shortly after sunrise on October 1, 1981. Spectacular propagating roll cloud formations of this type are observed with some regulari ty during September and October along the tropical southern margin of the Gulf of Carpentaria, where they are known as the 'Morning Clory.' The base of the cloud is estimated to be about 0.3 km and the top lies at about 1.5 km. The position of the cloud line marks a complex localized region of intense vertical and horizontal wind shear near the surface. The motions of the cloud elements in the strong up-draft along the leading edge and down-draft along the trailing edge combine to give the visual impression tha the cloud line is rolling backward as it propagates. Solitary waves are only rarely served as visible, propagating roll clouds. They usually occur as sudden, unexpected, clear-air disturbances which represent a potentially serious wind shear hazard to aircraft (especially jet aircraft, with their relatively slow response) during landing and takeoff. (Photo courtesy of D. R. Christle)

tary waves, or solitons, occur frequently in the upper layers of the oceans and in inland lakes and fjords. They are also a dynamical feature in the Martian atmosphere.

The first definitive observations of solitary

waves in the lower troposphere were made in 1976 at the Warramunga Infrasonic Array located near Tennant Creek in the arid interior of Australia's Northern Territory. These observations have since been extended through the use of portable microbarometer arrays to determine the coherence and evolution of nonlinear wave disturbances as they propagate over the northern Australian region Perhaps the most important result of this detailed study is the recognition that solitary waves are a commonly occurring, ubiquitous component in the dynamics of the lower atmosphere. Nonlinear waves of this type are by no means unique to northern Australia Large-amplitude solitary waves may be expected to occur wherever conditions of lowlevel stability prevail, and thus they should be regarded as a significant, world wide hazard

Solitary waves in the lower atmosphere take the form of isolated, single-crested waves of elevation which propagate predominantly as clear-air disturbances in a boundary layer inversion waveguide. They are produced quite naturally in the asymptotic decay of any large

amplitude, long-wave disturbance. Under conditions of high humidity such as those sometimes found in maritime areas they may be accompanied by a low-level, propaga roll cloud formation. The 'Morning Glory' of the Gulf of Carpentaria (see cover) is a spectacular example of a visible manifestation of a solitary wave. Cloud formations of this type are relatively rare, however, and are seldom seen in inland regions. It concerns aviation greatly that even in coastal areas these large amplitude waves usually occur without warr ing as sudden clear-air disturbances.

Solitary waves in the lower atmosphere of ten exhibit closed circulation in the relative streamline flow pattern. Winds near the surface in these horizontal propagating vortices exceed the speed of propagation and may present a particularly severe hazard to aircraft operating at low altitudes. The leading up-draft and trailing down-draft in atmoheric solitary waves may exceed 8 m s⁻¹. Maximum horizontal winds occur at the center of the wave near the surface and their speeds typically range from 10 to 15 m s $^{-1}$, although occasionally they may be much

These transient horizontal and vertical wind shears can affect the performance of aircraft in a variety of ways. Perhaps the most serious situation occurs when an aircraft en-

counters a solitary wave from the front during final approach. In this case the aircraft will first rise above the glide path under the positive influence of increasing head-winds and up-draft. The normal reaction of a pilot n this situation will be to decrease thrust or increase drag in an attempt to return the aircraft to the standard glide path. This action combined with the sudden loss of lift along the trailing edge of the wave due to decreasing head-winds and down-draft could leave the aircraft dangerously close to the ground and well short of the runway threshold. Conversely, runway overshoot is produced by solitary waves propagating along the direction

The study of atmospheric solitary waves during the coming year will focus primarily on the specific meteorological factors which lead to their production and long-range propagation. An investigation of the wind shear hazard posed by these waves to aviation in the Australian region has been completed. Detailed findings have been sent to all authorities concerned with air safety and an article on the subject by D. R. Christie and K. J. Muirhead will appear in Aust. Met. Mag., 31,

This news item was contributed by D. R. Christic of the Research School of Earth Sciences, The Australian National University, Ganberra.

Books

Tectonophysique et Géodynamique: Une Synthèse Géologie Structurale-Géophysique Interne

L. Lliboutry, Masson, Paris, France, 339 p.,

Reviewed by Navier Le Pichon

Lliboutry is an imaginative physicist with a vast scientific knowledge. On most problems that he discusses, he likes to formulate his own solutions, and he formulates them with frankness and, often, abruptness. I was, thus, curious to read his new textbook, which is for geological as well as geophysical university

I must say that I was not disappointed. This is an original and interesting book, and I know of no equivalent. It has an excellent table of contents: carthquakes and structure of the earth; earth magnetic field; remanent magnetization; seafloor spreading; subduction; present plate kinematics; past plate kinematics; nature of crust and mantle; isostasy low velocity zone, and heat flow; vertical motion; elastic and plastic deformations and ruptures; mechanical properties of plates and mantle: nature of lower mantle and differentiation of crust and hot spots; driving mechanisms; tectonic mechanisms; and orogenesis. There is a limited amount of mathematics. Consequently, geologists should not find it too hard reading, although the demonstra-tions may be too concise for most students in geology. On the other hand, the geological vocabulary is very limited, and each new term is introduced by a short explanation. No previous knowledge of any geology or geophysics is assumed. References are given in an abbreviated form within the text, and there is a combined subject-author index. The book is well illustrated, mostly with generally well-

chosen figures from major papers.

This is a physicist's book. Lliboutry tries to discuss the physical processes behind the ma-jor geodynamic phenomena and to show that many popular theories have fairly weak bases. This often leads him to propose new ideas or hypotheses, sometimes controversial and based on his own prejudices; for example, he insists on a high 10²⁵ P viscosity lower mantle

In detail, I have found many points where I disagree and a few that are simply not cor-· evample, his summary ent evidence on the viscosity of the lower mantle is biased and does not do justice to the work of Peltier and his collaborators (p. 242). There is no Figure 5-13 (p. 52). He considers guyots and seamounts as synonyms (p. 57). He states that the quasi-totality of the earth volcanisms occurs along subduction zones which ignores all the mid-oceanic underwater volcanism (p. 249). He states that most of the sediments in 'eugeosynclinal' se-ries are of deep oceanic basin origin and have been piled up in the subduction zone by Rccretion, ignoring the importance of locally derived arc sediments (p. 307). He proposes for the Messinian Mediterranean evaporitic layer a deep basin origin and compares 'un peu' its formation to the formation of the present Red Sea hot brines, which is not compatible with recent geologic evidence (p. 323). And, this list is far from exhaustive.

But these are relatively minor points within this well-constructed and highly readable book. To get its flavor, it may be best to quote Lliboutry on geosynclinal terminology which he finds confused, useless and danger-ous or on the notion of orogenic cycle, which he attributes to the persistence during a long period, of the order of 100 M.Y., where two

continents have been colliding, of a thin lithosphere which reaches the plasticity threshold at each progenic phase.' This is indeed the main conclusion of this book, which integrates in a satisfactory way continental deformation within a broad plate tectonic framework. Its reader progressively realizes that the geodynamic evolution of the surface of the earth is controlled by the mechanical properties of the plates which, unfortunately are still poorly known, although we do know a great deal more than a few years ago.

Xavier Le Pichon is with the Laboratoire de Géodynamique, Université Pierre et Marie Curie,

Causes and Effects of Stratospheric Ozone Reduction: An Update

Committee on Chemistry and Physics of Ozone Depletion and the Committee on Bio-logical Effects of Increased Solar Ultraviolet Radiation, National Academy Press, Washington, D.C., xi + 339 pp., 1982, \$13.95.

Reviewed by Guy Brasseur

In 1976, the National Academy of Sciences released a report entitled Halocarbons: Effects on Stratospheric Ozone. The purpose of this study was to evaluate the likely effect of chlorofluorocarbons (CFC's) on the ozone

layer in the atmosphere. A number of publications on the same subject have been prepared since then by different official bodies (NASA, World Meteorological Organization, European communities, the British government, etc.). The opinions expressed in these reports were not always in reement and even sharply differed in certain cases.

More recently, at the request of the U.S. EPA and in accordance with the Clean Air Act, as amended in 1979, the National Research Council has provided an assessment of the state of knowledge on ozone depletion and its effects on public health and welfare. The report whose purpose is to assess the most recent scientific information has been

published by National Academy Press. The report is divided into two parts. The first part, prepared by the Committee on Chemistry and Physics of ozone depletion chaired by Charles H. Kruger, Jr., reviews the processes determining the ozone concenrine, oxides of nitrogen, and other species. It describes the current status of stratospheric models and discusses our ability to detect trends in ozone in relation with any anthro

pogenic action. In its conclusion, the first part of the report states that 'if the production of CFCs ntinues into the future at the rate existing in 1977, the steady state reduction in total zone, in the absence of other perturbations would be between 5 and 9 percent.' These numbers are lower than previous estimates which shows the necessity of updating frequently our knowledge in stratospheric chemistry. The report also indicates that 'on the whole there have been substantial improvement in the agreement between model predictions and observed profiles of trace species. There are a few exceptions, however, and, since the uncertainties can be hardly quantitatively estimated, it is suggested that 'the discrepancies should be resol future by an orderly application of the scientific method with appropriate interaction be-tween theory and observation. Finally, the problem of simultaneous perturbations is . considered. Ozone may be altered not only by CFCs but also by an increasing emission level

of nitrous oxide in association with agricultural practices, disposal of human and animal wastes, and possible combustion. Moreover, the corresponding ozone reduction might be partly offset by the increased concentration of carbon dioxide or methane. It is therefore recommended (1) to maintain a coordinated research program to understand the spatial and temporal distribution of the key trace species including atmospheric observation, laboratory measurements, and theoretical modeling; (2) to monitor ozone, water vapor. and temperature, using both satellite and ground-base systems; and (3) to assess the consequence for stratospheric ozone of the emission in the atmosphere of all relevant gases such as CFCs, and CH₃Cl, CH₃CCl₃, N2O, CO2, and CH4. Other vehicles such as balloons and aircraft will also contribute to

The text devoted to the chemistry and the physics of ozone depletion is very clear and well written. It is based on six papers provided by six consultants and published as appendixes: (1) Perturbations of the Stratosphere and Ozone Depletion, by R. J. Cicerone; (2) Stratospheric Perturbations-the Role of Dynamics Transport and Climate Changes, by R. E. Dickinson; (3) Recent Developments in Stratospheric Photochemistry, by S. C. Wofsy and J. A. Logan; (4) The Measurement of Trace Reactive Species in the Stratosphere: A Review of Recent Results, by J. G. Anderson; (5) Trend Analysis of Total Ozone, by H. A. Panofsky; and (6) Detection of Trends in the Vertical Distribution of

Ozone, by A. B. Pittock. The length of the six appendixes is quite disproportional, which reduces the overall coherence of the text. However, these individual contributions are very readable and contain much useful information. The reader particularly interested by these questions should also refer to the report published by WMO and entitled The Stratosphere 1981: The-

ory and Measurements

The second part of the report is devoted to the biological effects of increased solar ultraviolet radiation. It has been drawn by a committee under the chairmanship of R. B. Setlow. Three topics are covered: (1) molecular and cellular studies. (2) ecosystem effects, and (3) human health effects. It is concluded that DNA is probably the primary target in animal cells for most deleterious effects of UV-B and that the major injury to DNA appears to be the formation of pyrimidine dimers which distort the normal DNA helical structure. Both UV-A and UV-B are also detrimental to plant growth, but the adaptability of plan pecies appears to be sufficient to maintain food crop yields. UV-B radiation can also damage aquatic organisms, but there is no information to predict the magnitude of such adverse effects.

The relationship between increased solar radiation and the appearance of skin cancers has been widely discussed in recent years since more than 90% of skin cancers other than melanoma seem to be attributable to sunlight. The report states that a 1% increase in UV-B would give a 1-2.5% increase in basal cell skin cancers and a 2-5% increase in amous cell skin cancers. The appearance of skin melanoma is partly due to sunlight but probably also to other factors. A prediction of enhanced incidence due to increased exposure to UV can therefore not be made. Models of light-induced melanomas are required together with epidemiological studies based on clinical and histological studies.

In summary, the report accomplishes its intended purpose quite well. It should give the policy makers a good assessment of our present knowledge and of the uncertainties on. the causes and effects of ozone depletion.

Guy Brasseur is with the Space Aeronamy Institute m Brussels, Belgium.

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POSITIONS AVAILABLE

Faculty Position/CSM. The Departments of Geology and Geophysics at Colorado School of Mines anikipate an opening for a joint appointment at Professor of Geology and Geophysics to commence September 1, 1983.

The successful applicant will be expected to teach courses and conduct research integrating exploration geophysics with petroleum geology. Applicant should possess the Ph.D. degree and responsible experience in exploration research and teaching.

A resume and references should be forwarded to Dr. J. J. Finney, Head; Geology Department or to Dr. George V. Keller, Head; Geophysics Department of Colorado School of Mines; Golden, Golorado 80401. Glosing date for applications is April 15, Calegado School of Mines; Golden, Golorado School.

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Faculty Position in Hydrology/College of Forest Resources, University of Washington. The Gollege of Forest Resources of the University of Washington invites applicants for a tenure track position in the area of forest hydrology. The opening is at the Assistant Professor level and is a 12-month appointment. Candidates should have a Ph.D. and either academic training or professional experience inforestry. Experienced candidates of exceptional ability and non-U.S. residents will be considered. A strong background in basic sciences including quantitative methods is essential. The successful candidate and graduate teaching and to develop a strong intendistiplinary research program. The position will be available on or after July 1, 1983. Send application, curriculum vitae and three letters of recommendation to: Dr. Robert L. Falmonds, Chairman, Hydrologist Search Committee, College of Forest Resources, University of Washington, Seattle, Washington, 98195, USA. The closing date for application is May 15, 1983.

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tion equal opportunity employer.

Tenure Stream Position in Survey Science. The University of Toronto (Erindale Campus) is accepting applications for a tenure stream position in Survey Science at the Assistant Professor level, effective July 1, 1983. A Ph.D. or equivalent is required. The candidate will be expected to teach and conduct research in one or more fields of Survey Science. Expertise is particularly sought in the fields of photogrammetry, digital mapping and land information systems; however, applications submitted by qualified persons in any other speciality in Survey Science, such as geodesy and hydrography, will also be considered. In any case, a strong orientation and interest in computer applications is required. Salary will be in accordance with experience and qualifications.

tions.

Applications, including detailed curriculum vitae, publications lists and names of three referees, should be submitted before March 1, 1983 to Professor R.C. Gunn, Survey Science, University of Toronto, Erindale Campus, Mississauga, Ontario L5L 1C6, Canada.

Physical Oceanographer/Oregon State University. Assistant or Associate Professor, depending on experience. Applicants may be observationalists or theoreticians but must have a Ph.D. in the physical sciences, have demonstrated the ability to conduct independent high-quality research and are expected to obtain research funding. Dutles include teaching and supervision of graduate students. Interested candidates should aubmit a resume and names of three references by I March 1983 to G. Ross Heath, Dean, School of Oceanography, Oregon State University. Covalis, OR 97331.

Affirmative Action/Equal Opportunity Employer. Position in Petrology/Rice University. Houston

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Position in Petrology/Rico University, Houston,
Texas. The Department of Geology has a tenure,
track opening beginning July 1983 with starting level of appointment depending on the experience of
the candidate. The faculty member is expected to
establish, or continue a vigorous research program
in petrology and to participate in teaching in minertentially interested include: igneous petrology,
metamorphic petrology, ore deposition, experimental petrology, interactions of fluids with rocks and
sediments, isotope geochemistry, but other specialties are not excluded from consideration. Available
research facilities of the Department lactured: electron-microprobe, ICP-spectrograph, Ar-Ar dation
and stable light increase. and stable light isotope mass-spectrometry. Send and stable light isotope mass-spectrometry. Send curriculum vitac, a statement of planned research, and names of at least three references to Dr. A. W. Bally, Chairman, Department of Geology, Rice University, P.O. Box 1892, Houston, Texas 77251.

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Assistant Research OceanographerSiO. The Oceanography invites physical oceanographers to Oceanography invites physical oceanographers to apply fir a position as Assistant Research Oceanography invites physical oceanographers to apply fir a position as Assistant Research Oceanography fir a position as Assistant Research Oceanography. It is presearch equivalent of Assistant Professor (Ph.D. in physical ackences or equivalent degree required). Candidate must have strong background in applied mathematics and fluid dynamics; strong interest in ocean dynamics; and proven research and proven or candidate obtaining extramural support. It is expected that the majority of research effort during the two years will be devoted to the theory and analysis of data on Kuroshio variability. Salary range is \$22,000-456,800 commensurate on qualifications. Position start date is approximately 4/1/85. Please Salvy, Chairman, Ocean Research Division Jolia, CA \$2093 by March 15, 1983. For additional information about the position cantact Dr. Peter.

San Diego is an Equal Opportunity/Affirmative Action Employer. Assistant Professor/University of Alberta. The Department of Physics at the University of Alberta Invites applications for a tenure track position at the level of an Assistant Professor in Physics in any of the following areas:

level of an Assistant Professor in Physics in any of the following areas:

1. Astrophysics and Astronomy;
2. Geophysics (Electromagnetic methods);
3. Theoretical Physics (Medium Energy, Particle Physics, Relativity and Cosmology).

The 1982/83 salary range for an Assistant Professor is \$27,720-\$39,820 per annum.

Applications will be received until May 1, 1983.

The Department of Physics offers both undergraduate and graduate degrees in Physics and Geophysics. The Department currently consists of 47 faculty Members, 36 Research Associates and Post-Doctoral Fellows and 50 Graduate Students.

Candidates interested in applying should submit a curriculum vitae plus the names of three (3) referees to:

Chairman

Chairman

Department of Physics

University of Alberta

Edmonton, Alberta, Canada

T6C 21

The University of Alberta is an equal opportunity employer but, in accordance with Canadian immigration requirements, priority will be given to Canadian cidzens and permanent residents of Canada.

Physical Occanographer/Computes

Physical Oceanographer/Computer Programmer. The Florida State University is seeking applicants to help carry out advanced research that involves numerical modeling and time series analysis. Candidates should have an M.S. in physical ucean-parably or computer science and expendence with Candidates should have an M.S. in physical oceanography or computer science and experience with
principles of ocean circulation modeling and oceanographic data processing. Experience on CDC mainframes plus Fortran IV is particularly desirable. Posilon available to start immediately, Rank is Research Auststant. Salary will be competitive
according to training and experience. Send resume
and professional references by March 28, 1983 to Y.
Hsuch, Department of Oceanography. Florida State
University. An affirmative action/equal opportunity
employer.

Naval Postgraduate School. The Department of Oceanography invites applications for the position of Adjunt Research Professor in the Ocean Turbulence Laboratory. The successful applicant will be responsible for the organization and execution of oceanic urbulence measurements as well as the interpretation and reporting of the obtained data. The position requires a Ph.D. or equivalent in Physical Oceanography, 8 years of post-doctoral experience with oceanic measurements and data interpretation, and some familiarity with turbulence instrumentation. The Ocean Turbulence Laboratory is actively engaged in the measurement and interpretation of oceanic turbulence data from a variety of environments obtained with several type of vehicles. The successful candidate will be expected to contribute to the growth and development of the scope of the research performed by the laboratory.

Applicants should send a resume, statement of research record and interests, and the names of at least three references to, Prof. Thomas R. Osborn, Code 680. Naval Postgraduate School, Monterey, Applications will be considered until March 8.

CA 93940.

Applications will be considered until March 8, 1983. Applicants should provide a curriculum vitae, three professional references, and a statement of professional (research and instructional) goals. Send letters of application to: Professor Christopher N. K. Mooers, Chairman, Department of Oceanography, Naval Postgraduate School, Monterey, CA 95940. Phone: (408) 646-2552/2553.

An Equal Opportunity/Affirmative Action Employer.

Research Associate/Upper Atmospheric Physics. The National Research Council (Canada) is building a multi-instrument ground based research facility called CANOPUS. One part of CANOPUS is a Data Analysis Network which will provide interactive access to the CANOPUS data by scientists across Canada. A research associated with implementing and operating this network. This position will allow some independent research on aspects of the CANOPUS data and the holder of the position would be encouraged to undertake such research. The position requires a Ph.D. in some aspect of upper atmospheric physics (preferably ground based) and extensive computer experience. Any related experience in computer networking, etc. would be an advantage. The initial salary will be in the trange from \$24,000 to \$27,000 per year, depending on experience. The appointment will be initially made for two years and commences as soon as possible.

Send resumes and the names of three referees to:

Professor J. A. Koehler Institute of Space and Atmospheric Studies University of Saskatchewan Saskatoon, Saskatchewan S7N 0W0 Canada.

Geophysicists/Institute for Geophysics, University of Texas at Austin. Applications are invited for research scientists with a Ph.D. in the general areas of marine geophysics or theoretical seismology. We are particularly interested in innovative individuals who wish to pursue a career primarily in research with some teaching and graduate student reaponsibilities. The institute is located in Austin and operates closely with the Department of Carles by the brittes. The Institute is located in Austin and operates closely with the Department of Geological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geophysics. Research facilities include a 167' ship equipped with state-of-the-art multichannel and high resolution seismic reflection and OBS seismic refraction capabilities.

Applicants should have a demonstrated ability to do creative research. Both midcareer and recent Ph.D.s are encouraged to apply. Applicants should submit resume, the names of at least three references and a statement of research plans and priorities to:

A. E. Maxwell, Director
Institute of Geophysics
University of Texas at Austin
Austin, TX 78712
While late applicants will be considered, we prefer
to have applications in hand by April 15, 1985.
The University of Texas is an equal opportunity/
Chemical Occurrence.

Chemical Oceanographer, Assistant Professor, tenure track position for applicants with recent tenure track position for applicants with recent Ph.D. and competence and interest in contemporary clude development or research projects and some teaching. Salary negotiable depending upon experience and qualifications. Submit resume and names and addrense of three references by I March 1983 to G. Ross Heath, Dean, School of Oceanography, An Affirmative Action/Equal Opportunity Employer.

Marine Geophysicial/Texas A&M University. The Department of Oceanography of Texas A&M University will have an opening for a tenure track haulty member in Marine Geophysics beginning September 1983. Preference will be given to candidates with a strong quantitative background in a wale range of geophysical topics and who have both interest and experience in marine exploration.

The successful applicant will be expected to teach undergraduate and graduate courses and to conduct a vigorous research program in his or her specialty. The position is to be filled at the level of Assistant Professor. A Ph.D. is required for this position. Salary is negotiable depending upon experience and qualifications.

Applicants should submit a vita along with a letter describing his/her research and teaching goods and names of five persons for reference to Professor R. O. Reid, Head, Department of Oceanography, Texas A&M University, College Station, TX 77843. The dosing date for applications is March 15, 1983. Texas A&M University is an affirmative action/equal opportunity employer.

Faculty Position/Department of Geology, University of Illinois at Urbana-Champaign. Applications are solicited for a tenure track assistant professor position in experimental rock physics. The position is expected to be filled by August 1983. Salary is open depending upon experience. We are seeking a creative Individual who is interested in either Individual applications. An earned Ph.D. is required. The Department of Geology, the Materials Research Laboratory and the Engineering College of the University together offer excellent research facilities for rock physics studies. For equal considerations, interested individuals should send curriculum vitae, llst of publications, research interests and the natures of three or more references by March 5, 1983 to:

Abbert T. Hsui

Department of Geology
University of Illinois at Urbana-Champaign
1301 West Green Street
Urbana, Illinois 61801
217-338-7732.

University of Illinois is an equal opportunity/allir-

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Postdoctoral Position in Dynamical Meteorology. The Department of Atmospheric Sciences at the University of Washington announces a research position for work on problems of large-scale dynamics and transport in the stratosphere and mesosphere. The successful applicant should have demonstrated capability in diagnostic studies of atmospheric circulation and/or in dynamical theory and modeling. Position is for one year with possibility of extension to three years and begins about July 1, 1983. Candidates should send curricultum vitae and three letters of reference to:

of reference to:
Prof. Conway B. Leovy
Department of Amospheric Sciences AK-40
University of Washington
Scattle, WA 98105
For information phone 206-543-4952.
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The Pennsylvania State University/Faculty Positions. The Department of Geosciences invites applications for three (3) tenure track faculty positions, which are expected to remain open until filled by outstanding geoscienciss in any of several fields of specialization. The faculty rank associated with each position is presently open, although salary funds currently available are sufficient for at most one senior full professorship. Salaries, which are competitive, will be commensurate with the experience and qualifications of the appointees. The successful candidates must be, or have demonstrated the potential to become, nationally recognized leaders in their fields. They must also have an interest in their fields. They must also have an interest in their fields. They must also have an interest in teaching and advising graduate and undergraduate students. Persons having an interest in collaborative research with other department faculty are preferred. Instructional and research areas in which particular needs have been identified include, but are not necessarily limited to: aqueous geochemistry, with emphasis on low-temperature rock-water (groundwater) interactions; heavy intopeltrace element geochemistry, with emphasis on global geophysical and geological spotications; tectonical processes and observable manifestations of them; sedimentary geochemistry, with emphasis on quantitative aspects of carbonate petrology or clay mineralogy. **Tory mineralogy**, with emphasis on petrological applications of crystallochemical methods; and modeling of dynamical earth processes using appropriate physical and maltiematical representations will be based to see a full these three positions will be based to see a full these three positions will be based to see a full these three positions will be based to see a full these three positions will be based to see a full these three positions.

The selection of persons to fill these three posi-tions will be based in part on the extent to which their future research efforts will complement and further strengthen our programs in Geochemistry and Mineralogy, Geology, and Geophysics. Quali-fied persons should, therefore, include a brief de-scription of their future research objectives with their résumés and the names of three references, and send to:

id send to:

C. Wayne Burnham, Head
Department of Geosciences
The Pennsylvania State University
503-B Delke Building
University Park, PA 16802.
The Pennsylvania State University is an affirmative action/coural opportunity eroplover.

Virginia Polytechnic Institute and State University/Structural Geologiat. The Department of Geological Sciences invites applications for a tenure-track position in Structural Geology at the Assistant or Associate Professor level. The position involves teaching at the graduate and undergraduate level and supervision of graduate arudent research, Candidates should be process-oriented with interests in field related problems. A Ph.D. and strong research is April 15. The position is available from Septem. To apply send a wire self-time.

ber 1, 1983.

To apply send a vita with list of publications, summary of present and proposed research and the names of three references to: Kenneth A. Eriksson, Chairman of Search Committee, Department of Geological Sciences, VPI & SU, Blacksburg, VA 24061.

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Assistant or Associate Professor/CSM. The Geology Department of the Colorado School of Mines in vites applications for a faculty position commending September 1, 1983 as Assistant or Associate Professor of Geology in the specialty of Paleontology and Sedimentary Geology to teach courses at the undergraduate and graduate levels, direct theses and conduct research in these areas. The Pf.D. degree is required. Salary is dependent upon experience, quired. Salary is dependent upon experience.

The deadline for applications is April 16 j. 1983.

J. Finney: Heid. Geology Department: Colorado School of Mines: Ocidant Colorado School of Mines: Ocidant Colorado School of Mines: An Alignative Action (Colorado School of Mines: An Alignative Action (Colorado School of Mines: An Alignative Action (Colorado School of Mines: Ocidant Colorado Scho

Atmospheric Chemistry & Aeronomy Division (ACAD) and Scientific Computing Division (SCD) Ph.D. Scientist I or H. The National Center for Atmospheric Research in Rouder, (CO is seeing a centret to establish and manage the scientific research in incoherent scatter Radar data base. Will interact with neer and radar community to establish research project to insure appropriate scientific use of data base. Position requirements include Ph.D. degree or espiralent, research experience is sensionly playsus, electronic engineering, atmospheric science, or closely related liefd. Familiarity with the Incoherent Scatter Radar techniques for measuing the properties of the iomosphere, magnetosphere, and atmosphere. Demonstrated high level of skill in advanced FOR PRAN programming, numerical modeling data reduction techniques devel III) requires national scientific recognition and demonstrated leadership skills in and promoting Incoherent Scatter Radar tescarch. This is a term position subject to animal review and continued funding for project. Send resume PROMPTLY to Euler Bazzon, NCAR, P.O. Brys 3000, Boulder, CO 8000 or call 303-191-5151 ext. 581 get information.

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Atmospheric Chemistry & Aeronomy Division (AGAD) and Scientific Computing Division (SCBy Ph.D. Scientist II or III. The National Center for Atmospheric Revearch in Boulder, (CO is seeing a scientist to establish and manage the scientific research in Intoherent Scatter Radar data base. Will interact with user and radar community to establish research propert to insome appropriate scientificus of data base. Position requirements include Ph.D. degree or espawalent, research experience in aeronomy physics, electromy engineering, atmospheric science, or closely related light. Familiarity with the Incoherent Scatter Radar techniques for measuring the properties of the ionosphere, magnetosphere, Demonistrated high level of skills in advanced FORTRAN programming, numerical modeling data reduction to fungues. (Level III) requires national wientific recognition and demonstrated leadership skills in and promoting Incoherent Scatter Radar research. This is a term position subject to annual review and continued funding for project. Send resume PROMPTLY to Estler Blazon, NCAR, P.O. Box, 2001, Bonther, CO 8030 or call 303-491-5151 ext. 581 to get information.

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Vincent C. Kelley and Leon T. Silver Graduate Fellowships

DEPARTMENT OF GEOLOGY THE UNIVERSITY OF

The Department of Geology of the University of New Mexico invites ap plications for the Vincent C. Kells and Loon T. Silvor Graduate Fellow ships. The followships will b awarded on the basis of the scholastic record and academic promise of graduate applicants. Each fellowshi will provide for a generous living st pond of \$1,000/month for 9 to 12 months, and up to \$2,000/year to Iravol and rosearch expenses. The Caswell Silver Foundation will pay a tultion and university fees. The awards are made on an annual basis but may be renewed for up to three years for those individuals in the masters program, and up to live years to those individuals completing bol M.S. and Ph.D. degree requirement A M.S. thesis may be used as a basis for Ph.D. program. Preference will be given to, but is not restricted to applicants for the Ph.D. program.

An application for admission to the UNM Graduate Program, transcripts Graduate Record Exam results (ver bal, math and geology), three letters of reference and a brief statement of research goals are required for consideration for the fellowships. Apr piloation materials may be obtained

Rodney C. Ewing Chairman Department of Geology University of New Mexico Albuquerque, New Mexico 87131



Experimental & Solar Physicists

Lockheed Missiles and Space Company's Research Laboratory in Palo Alto, CA, has openings for a SOLAR PHYSICIST and an EXPERIMENTAL OPTICAL AERONOMY PHYSICIST in our Space Sciences Laboratory. These Labs are located on the beautiful San Francisco Peninsula just minutes south of Stanford University.

Solar Physicist

The successful applicant will be expected to conduct and publish original research on solar flares as a member of the Lockheed X-Ray Polychromator (XRP) team. This research WILL make use of existing XRP and related data or new observations to be acquired following the repair of the Solar Maximum Mission (SMM) in 1984. As an active member of the XRP team, this physicist will participate in planning and executing the observing program of the renewed XRP

This position requires a PhD degree or its equivalent plus experience in solar research. A background in plasma physics is highly desirable.

Experimental Physicist

A position in experimental optical aeronomy is currently open where the candidate is expected to carry out experimental/observational programs in auroral and airglow physics using ground based, airborne and spacecraft based optical instruments. This physicist will participate in existing programs, become involved in the development of data reduction techniques for analyzing photometric spectroscopic and imaging data and eventually be expected to develop one's own interests in research programs. A PhD in physics, space physics or a related discipline, the experience in scientific data analysis, the development of space hardware and the involvement in satellite, rocket or shuttle programs is essential. A willingness to travel to remote sites will be required.

Both of these appointments and salary levels will be commensurate with the credentials of the person selected. Qualified and interested candidates should send their resumes, references and list of publications to: LMSC, Professional Employment, Dept. 583-0383, P.O. Box 504, Sunnyvale, CA 94086. Lockheed is an equal opportunity, affirmative action employer. U.S. CITIZENSHIP IS REQUIRED.

Lockheed Missiles & Space Company

Navid Postgraduate School. The Department of Oceanography invites applications for the position of Adjunct Research Professor in the Ocean Turbulence Laboratory. The successful applicant will be responsible for the organization and execution of oceanic turbulence measurements as well as the interpretation and reporting of the obtained data. The position requires a Ph.D. or equivalent in Physical Oceanography, 3 years of post-doctoral experience with oceanic measurements and data interpretation, and some familiarity with turbulence instrumentation. The Ocean Turbulence Laboratory is actively engaged in the measurement and interpretation of oceanic turbulence data from a variety of environments obtained with several types of vehicles. The successful candidate will be expected to contribute to the growth and development of the scope of the research performed by the laboratory. Applicants should send a resume, statement of research record and interests, and the names of at least three references to Prof. Thomas R. Osborn, Code 680r, Naval Postgraduate School, Monterey, CA 93940.

Applications will be considered until March 15.

A 93940.

Applications will be considered until March 15, 1983. Applicants should provide a curriculum vitac, three professional references, and a statement of professional (research and instructional) goals. Send letters of application to: Professor Christopher N.K. Mooers, Chairman, Department of Oceanography, Naval Postgraduate School, Monterey, CA 93940. Phone: (408) 646-2552/2553.

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Sedimentologiat/Wright State University. The Department of Geological Sciences invites applications for a position in sedimentology, beginning September 1983. The position will be either for a tenure-track assistant professorship or a one-year visiting position, depending upon qualifications. A clastic sedimentologist is preferred, but strong candidates in any selimentology field will be considered. The successful candidate will be expected to teach at the undergraduate and graduate levels and to participate in the department's active graduate program. The department is active with 12 faculty with an emphasis on professional practice, yet maintaining a firm committed.

The department is active with 12 faculty with an emphasis on professional practice, yet maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435
Wright State University is an affirmative-action/equal opportunity employer. Closing date for the position is 15 June 1983.

Faculty Positions/Depart University. The Depart

Faculty Positions/Drexel University. The Department of Physics and Atmospheric Science has several openings for both visiting and tenure track faculty at all levels starting in the full of 1985. Applicants must have strong tenshing and present interests in by at an ievers starting in the tail of 1902. Appending must have strong teaching and research interests in one or more of three areas in the Department: Atmospheric Science—mesometeorology, satellite meteorology, and remote sensing of the atmo-sphere:

sphere;
EXPERIMENTAL PHYSICS—biophysics, quantum optics, nuclear and solid state physics;
THEORETICAL PHYSICS—atomic, molecular and the physics and non-linear. Interested persons should send resumes and the names, addresses, and telephone numbers of three

names, addresses, and semples.

Pr. Herman Newstein, Acting Head
Department of Physics and Atmospheric Science
Dressel University
Philadelphia, PA 19104

(215) 895-2707,
Second Philadelphia and Atmospheric Science of Philadelphia, PA 19104

(215) 895-2707,
Second Philadelphia and Opportunity and Drezel University is an equal opportunity and af-

Tenure-Track Faculty Position Chemical Oceanography/Marine Geochemistry. We have an operang for an Assistant or Associate Professor of Marine Chemistry, Chemical Oceanography, or Marine Geochemistry for September 1985. Candidates should hold a Ph.D. in an appropriate field and have their major research interests in coastal marine environments. By I March 1983 send a complete resume and have at least three letters of reference sent directly to: Dr. D.G. Capone, Chair, Chemistry Search Committee, Marine Sciences Research Center, SUNY Stony Brook, Stony Brook, NY 11794. SUNY Stony Brook is an equal opportunity/affirmative action employer. AK# 523.

Isotope Geologist/University of Wyoming. The Department of Geology/Geophysics invites applications for a tenure track position at the assistant professor level in isotope geology. The applicant's field of specialty may be stable or radiogenic isotopes. The successful candidate will be expected to teach undergraduate and graduate courses and conduct his/her own research program.

Current research at the University of Wyoming includes: crustal evolution in the Archean and Proterozoic; the systematics of magma contamination; carbonate diagenesis; fluid-rock interaction; and the tectonic evolution of compressional and extensional orogenic belts. We hope the successful candidate will complement these studies as well as develop a strong, independent program. Applicants should submit a vita, transcripts, a letter describing future research interests, and names of three references to Dr. Robert S. Houston, Head, Dept. of Geology/Geophysics, PO Box 3006, University Station, University of Wyoming, Laramie, WY 82071. Closing date for applications is February 28, 1983.

The University of Wyoming is an equal opportunity/affirmative action employer.

Faculty Position in Solid Earth Geophysics. The Department of Geological Sciences of Columbia University seeks applicants for a faculty position (tenure-track or tenured) in Solid Earth Geophysics. (tenure-track or tenured) in Solid Earth Geophysics, Consideration will be given to candidates in earth-quake selsmology, marine seismology, and other disciplines in Solid Earth Geophysics. Appointees would be expected to develop a vigorous research program at Lamont-Doherty Geological Observatory and to contribute to undergraduate and graduate teaching in Geophysics. Preference will be given to candidates with strong backgrounds in quantitative methods of analyzing geophysical data. Quallfied candidates should submit their curriculum vitae and the names of three referees to Prof. A.B. Watts, Chairman of Solid Earth Geophysics Scarch Committee, Lamont-Doherty Geological Observatory, Palisades, New York, 10964 by April 15th, 1985. Columbia University is an equal opportunity/affirmative action employer.

Faculty Positions/The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track assistant professors or visiting professors of any rank in August 1983. Preference will be given to experimentalists in any area for the tenure-track positions. Current research interests include astronomy, atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a reaumé and a statement of research interests, and have three letters of recommendation sent to Search Committees, Department of mendation sent to Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, 1A 52242.

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。在大学学院的中国工程,1986年1月1日,1986年1月1日,1986年1月1日,1986年1月1日,1986年1日,1986年1月1日,1986年1日,1986年1日,1986年1日,1986年1日,1986年1日,

Research/Senior Research Associate in Planetary Geology. A postura is open for a planetary geologist/geophysicist at the Lunar and Planetary Laboratory, University of Arizona. The applicant should have a Ph.D. in geology or geophysics and research experience in impact cratering, including cratering mechanics and the planetary cratering record. A resume and three letters of reference should be sent to: Robert G. Strom, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

The University of Arizona is an equal opportunity employer.

Postdoctoral Research Associate Mineralogy. Applications are invited for research in high-resolution and analytical transmission electron microscopy of minerals and their analogues. Experience in crystallography, materials sciences, or electron microscopy is desirable. Send resume (including transcripts), statement of research interests, and names of three references to Dr. P. R. Buseck, Department of Goology, Arizona State University. Tempe, AZ 85287. ASU is an EO/AA employer.

University of Nebraska-Lincoln/Geology. Seek tenure-track Assistant Professor in general area of tectonics, geophysics, structure and economic geology effective August. Teaching duties can be arranged to reflect specialty of successful applicant. Teach two courses per semester. Requires Ph.D. and strong commitment to excellence in teaching and research/publication. Minimum salary \$20,000, Apply by March 51 with application letter, vita, transcripts, and names of three references to Chairman, Department of Geology, University of Nebruska-Lincoln, Lincoln, Nebraska 68588–0340.

Affirmative Action/Equal Opportunity Employer.

Upper Ocean Physical Modeller. A postdoctoral position in upper ocean equatorial modelling supported by NSF is available in the Mesoscale Air-Sea Interaction Group at the Florida State University. Minimum salary is \$21,000/yr. Qualified Ph.D. should send vita and names of 8 references to Professor James J. O'Brien, The Florida State University, Tallahassee, FL 32306, or call (904) 644-4581.

PHYSICAL OCEANOGRAPHER

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CSIRO has a broad charter for research into primary and secondary industry areas. The Organization has approximately 7,400 employee—2,800 of whom are research and professional scientists—located in divisions and sections throughout Australia.

GENERAL: The CSIRO Marine Leboratories, which includes the Division of Flaheries Research and the Division of Oceanography, is Australia's principal marine research institution. About 200 scientists and support staff are employed in the Marine Laboratories, investigating the physical, otherwise and biological features including the physical.

Two well-equipped chartered vessels (53m and 43m) are available for research. The Australian Government has agreed to the acquisition by CSIRO of a modern oceanographic ship to replace the 43m vessel.

On-line access to a CYBER-76 computer is available.

DUTIES: Participate in the work of a research group undertaking analytic and/or numerical modeling of the formation, circulation and mixing of water masses in the upper kilometre of the ocean. The work includes analysis of historical data sets, and planning and implementation of oceanographic crutees for the collection of data.

QUALIFICATIONS: Applicants should have a PhD or equivalent qualification in oceanography or a related field, preferably with a strong mathematical background. They should demonstrate both a high level of aptitude for independent scientific research and an ability to collaborate with scientists working in related disciplines.

TENURE: A fixed-term appointment of 3 years with the possibility of a further term of two years. APPLICATIONS: In writing, stating full personal and professional details, the maries of at less! two referees, and quoting reference number A2568 should reach:

> The Chief Division of Oceanography CSIRO GPO Box 1538 HOBART TAS 7001 AUSTRALIA By March 18, 1983.

12th Annual One-Week Short Course on Hierarchical-Multiobjective Approach in Water Resources Planning and Management. 1983 Theme: The Increased Use of High Technology and Decision Support Systems in Water Resources Planning and Management, Cieveland, Ohio May 9-13. 1983. Contact: Y.Y. Halmes, Center for Large Scale Systems and Policy Analysis, Case Western Reserve University, (216) 368-4492.

STUDENT OPPORTUNITIES

Graduate Research Assistantiships in Earthquake and Exploration Seismology/University of Kansas. The computer acquisition of digital seismograms for a 20 + station seismic network covering the southern end of the Central North American Rift System and the development of techniques for Very High Frequency (500-1000 Hz) reflection seismology provide excellent opportunities for graduate study at the M.S. or Ph.D. level. For further information and/or application, please write:

audy at the M.S. or Ph.D. level. For fur mation and/or application, please write: Dr. George H. Rothe, Chairman Geophysics Program Department of Geology University of Ransas Lawrence, Kansas 66045 (913) 864-4974.

Postdoctoral Postfilon/Seismology. Postdoctoral support in seismology is tentutively available for up to a 24-month period. Seeking a recent Ph.D. with interest la regional seismic wave/surface wave propagation. Applications should be sent to: Dr. Robert G. Hermann, Department of Earth & Atmospheric Sciences, St. Louis University, Box 8090, St. Louis, MO 63156, 314-658-3120.
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St. Louis University is an affirmative action/equal opportunity employer.

Howard University. With an historic commitment to the education of disadvantaged Americans and third-world people. Howard University now offers graduate program leading to the M.S. in Geoscience. This new program is made possible by a grant from the Gult Cit Company. Current area of specialization are field geology/geophysics, geochemistry, and meteorology/hydrology. Eight sudents are in residence, including four women. Some aipends and assistantships are available. Potential students

Membership

Applications

Applications for membership have been re-

ceived from the following individuals. The

letter after the name denotes the proposed

primary section affiliation; the letter A de-

notes the Atmospheric Sciences section, which was formerly the Meteorology section.

Carl L. Axness (H), Dalila Benothman (V),

Mark Bergiu (O), Richard W. Couch (T), James E. Court (T), Donald W. Denbo (O), Jacques Dubois (T), Robert A. Edwards (G),

David R. Ford (H), James T. Gross (V), Take-

shi Hasegawa (S), L. R. Haury (O), Robert

Heinmiller (O), Gary L. Hitchcock (O), Wil-

ney G. Huppi (T).
R. W. Johnson (V), Jean-Marc Luck (V),
Glenn W. Lundell (O), Richard A. Lutz (O),

Michael C. Macaulay (O), Takaaki Matsuda (V), William M. Nally (S), Allen R. Reed (S),

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should write to Dr. Erlc Christofferson, Department of Geology and Geography, Howard University, Washington, D.C. 20059. Graduate Scholarships in Geophysics/University oming. 2000 and Chevron Fellowships M.S. and Ph.D. levels Up to \$10,500/year plus tuition

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Brumley (O). James Callian (GP). Antony D. Clarke (A), Edward M. Coppola (P), Vladimir Cvetkovic (H), Teresa M. Danovich (O), Shar-

on Deemer (H), Alan L. Deino (V), Robert E. Epice (SM), Raymond Gallan (S), David Goldberg (T), Bill Harbert (GP), Greg Hilder-

brand (V), Huseyin B. Iz (G), Isaac I. Kim

(V), Fluscyin D. 12 (G), 1888C t. Anni (S), Margaret J. Kingston (V), G. Mathias Kondolf (H), Anthony A. Longo (V), Craig E. Manning (T), S. Kimball May (O), John R. Nelson (T), Gregory J. Newman (H), Sylvia Newsom (GP), Duncan J. W. Norrie

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(O), Craig J. Pollock (SM), Duane J. Rosa (H), John R. Scala (M), Thomas D. Seeba (T),

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AGU

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Fellowship

The Individual selected will spend

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public policy questions.

Prospective applicants sho

public problems is desirable.

owance.

member, advising on a wide range of scientific issues as they pertain to

a broad background in science and

be articulate, literate, flexible, and

able to work well with people from

diverse professional backgrounds.

Prior experience in public policy is

not necessary, although such experi-

ence and/or a demonstrable interest

in applying science to the solution of

The fellowship carries with it a sti-

pend of up to \$27,000, plus travel al-

Interested candidates should sub-

mit a letter of intent, a curriculum vi-

tae, and three letters of recommen-

write or call Member Programs Divi-

sion, Congressional Fellowship Pro-

gram, American Geophysical Union,

Ington, D.C. 20009 (telephone: 462-6903 or 800-424-2488 outside the

2000 Florida Avenue, N.W., Wash-

Washington, D.C. area). Deadline: March 31, 1983

dation to AGU. For further details,

Associate Member

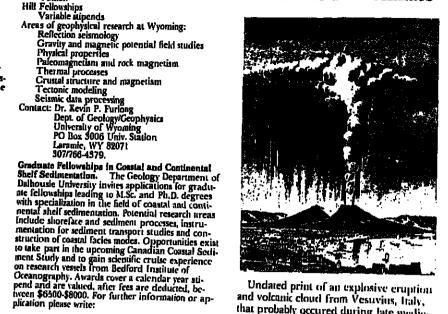
(H), Ann L. Tyler (P),

(M), Robert J. Williamson (H), Karen

Wishner (O), Edwin A. Wurtz (O).

Student Member

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\$2,500 summer stipend **Announcements Volcanoes and Climate** Tuition
Hill Fellowships
Variable stipends
Areas of geophysical research at Wyoming:
Reflection seismology
Gravity and magnetic potential field studies
Physical properties
Paleomagnetism and rock magnetism
Thermal processes
Crustal structure and magnetism
Termal processes
Crustal structure and magnetism
Tectonic modeling
Seismic data processing
Contact: Dr. Kevin P. Furlong
Dept. of Geology/Geophysics
University of Wyoming
PO Box 3006 Univ. Station
Laramic, WY 32071
307766-4379.
Graduate Fellowships in Goastal and Continents



Undated print of an explosive eruption and volcanic cloud from Vesuvius, Italy, that probably occured during late medieval or early modern time. Tephra fallout can be seen from the cloud at left, about the Ring of Somma (the remnant of the great Plinian eruption of A.D. 79, which buried Pompeii and Herculaneum (see Eas, December 28, 1982, p. 1345]). The Bay of Naples appears in the right foreground. See accompanying announcement of meeting on volcanoes and climate.

All all-day, interdisciplinary Symposium on the Climatic Effect of Volcanic Dust and Aerosols in the Upper Atmosphere will be held at the National Burcau of Standards in Boulder, Colo., March 18,

Approximately 14 nationally prominent speakers representing a broad spectrum of sciences (climatology, meteorology, space physics, terrestrial and atmospheric geophysics, volcanology, remote sensing, and glaciology) have been invited; they will discuss how their specialties contribute to the understanding of explosive volcanism's effects on the earth's annosphere and climate. Volcanic influence on climatic changes over the last 2000 years will be emphasized; newly acquired knowledge of volcanic dust and aerosol veils since the 1963 eruption of Agung, Bali, will be stressed. Since the advent of satellite and airborne laser radar (lidar) systems, explosive eruptions of considerable magnitude have occurred at Becrenberg Volcano, Jan Mayen Island; Fuego, Guatemala; Saint Augustine, Alaska; Mount St. Helens, Washington; and El Chichón, Mexico, These lidar systems are capable of rapid

surveillance of the presence, movement, and optical density of volcanic aerosols in the upper atmosphere. The symposium also will review modern climatic variations and historical eruptions that have produced chronologically dated nigh-conductivity layers in the Greenland and southern hemisphere glaciers. (The high electrical conductivity results from deposition of SO₄ particulate aerosols from the upper atmosphere.) Topics such as tephrochronology, historical writings, explosive eruption mechanisms, optical studies of twilight and auroral glow, and volcanic dust-veil index measurements of

volcanic clouds will be discussed in relation to the energy yield of known volcanic included as a special feature will be the presentation of new results from the Solar Mesosphere Explorer Satellite, cont by the National Center for Atmospheric Research and the astrogeophysics depart-ment at the University of Colorado. Implications for aircraft flights and for agricul-

ture also will be discussed. The symposium, intended for a national audience of scientists, the press, and interested laymen, will follow several days of review of national climatological programs in Boulder, including the annual geophysical monitoring of climate change and a one-day workshop (scheduled for March

17) on polar meterology. Presentations are by invitation only to provide a succinct, coherent, and well-integrated program. However, interested scientists, AGU members, the national press, and others may contact cochairmen Raymond D. Watta (telephond: 303-284-3493) or Jules D. Friedman (telephone: 308-284-3676) for information on attend-

308-284-5676) for information on attending.

The symposium is aponsored by the AGU Front Range Branch and is dosponsored by the Denver Bouiller chapter of the American Mejeorological Society in addition, the symposium is partly supported by a gift from Ball Brother Act of face Corporation

<u>Meetinas</u>

Canadian Geology, Geophysics, Minerals

The Joint Annual Meeting of the Geological Association of Canada, the Mineralogic Association of Canada, and the Canadan Geophysical Union will be held in Victoria British Columbia, May 11-13, 1983.

General sessions offered include crystal raphy and mineralogy; economic geologic Runcarung geology: geophysics; geochemis Recorded into metion: hydrogeology by ontology; petroleum geology; petrolog; pe ternary geology; sedimentology; statigral, structural geology; tectorics; and vokanol,

Three symposia will be offered: the R.F. W. Douglas Memorial Symposium (a copy ison of the Cordillera with other orogen); COCRUST results; and marine geoscience in Canada.

Among the special sessions proposed as eastern Pacific plate tectonic history and pasent regime; microplates, paleonagnetion, and paleontology of western North America thermal structure of the crust; modern alvarices in geochemical thermodynamic; qua ternary sea levels and crustal geodynamics and stable isotopes in the study of sedimenhosted mineralization.

Two short cornses also are scheduled (& Petrography: Its Principles, Methods, and Applications' and 'Sediment-Hosted Straitorn Lead-Zine Deposite'). Rounding on the meeting are poster sessions, 7 field trips before the meeting, and 10 field trips after.

Registration forms and additional informtion can be obtained from Tom Lietaer, Up versity Extension, Conference Office, P.O. Box 1700, Vactoria, B. C. V8W 2Y2 (telephone: 604-721-8475).

The chairman of the local organizing conmittee is A. Sutherland Brown.

Geophysical Year

The complete Geophysical Year last appeared in the December 21, 1982, Es. A holdface meeting title indicates sponsoship or cosponsorship by AGU.

New Listings

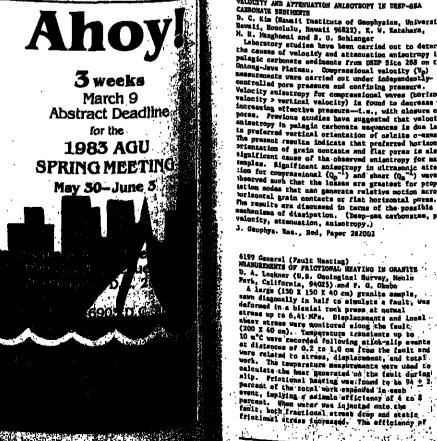
May 11-13, 1983 Joint Annual Meeting. Geological Association of Canada, Mineral ogical Association of Canada, and Cambin Geophysical Union, Victoria, B. C. Comb taer, University Extension, Conference Of fice, P.O. Box 1700, Victoria, B. C. V8W 2Y2; telephone: 604-721-8475).

September 3-7, 1984 Quadrennial Ores Symposium, Halkidiki, Greece, Sponsors, b ternational Ozone Commission of IAMAP. Commission of the European Community the Academy of Athens, and the World Mee prological Organization, (Christos S. Zerolo, Chairman, Local Organizing Committee Physics Department, Campus Box 149, Unversity of Thessaloniki, Thessaloniki, Green Send copy of information request to G. D. Walshaw, Secretary, International Ozone Commission, Clarendon Laboratory, Unive sity of Oxford, Parks Road, Oxford, OXI

Changes

sored by AGU.

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Particles and Fields— Magnetosphere

5775 Plesma instabilities

RPIKY ION ACOUSTIC WAVES IN COLLISIONLESS AURORAL SPIKY ION ACOUSTIC WAVES IN COLLISIONLESS AURORAL PLASMA
W. Lotho (Space Sciences Laboratory, University of California, Berkeley, CA 94720) and C. F. Keanel
A theory of spiky electric fields in 'Inverted V' precipitation regions is formulated and compared with recent spacecraft observations of solitary waves and double layers. It is proposed here that the electric flatds prepagate stong the magnatio field as perturbed fon-acoustic solitons which intensity by exchanging momentum with reflected particles. The solitons have minimum scale lengths of about 100 m and maniputum electric potential and field amplitudes of 1 - 10 V and 1 - 10 mV/nn. They propagate is the local fon-acoustic speed (c, -- 10 - 100 km/sec), Dopplantialized by the drift speed of upward flowing cold ions. Soth medicative and compressive spottens. Upward propagating compressive modes intensity whose the upward flow of ionsepheric lone seconds roughly 10 c, The medicative mode intensifies when the upward flow in consistent with the recent observations, although further subjects, both theoretical and experimental are required for an unembiguous interpretation. The evolution of localized lon-accoustic modes (upo smill supplication before the evolution of localized lon-accoustic modes (upo smill supplicate double layers is also discussed. Unonlinear waves, turbulant electric fields)
J. Gasobwe. Rea., Siue, Paper 2A1431

J. Geophys. Res., Blue, Paper 2A1431

5780 Wave propagtion A THEORY OF THE IO PHASE ASYMMETRY OF THE JOVIAN DECAMENTE BADIATION

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Laboratory for Extraterrestrial Physics, Interplanetary Physics Branch, MSB/Goddard Space Flight Center, Greenbelt, MB 2077:)

Me propose an explanation of an asymmetry in the co-currence probability of the Io-dependent Jovian decametric radiation. Me find that this asymmetry arises because when lo is in the northern part of the torus more intense Alfvén waves are generated propagating southward than northward. These waves then cause the escitation of decametric radiation in the northern ionosphere after reflection from the southern ionosphere. The asymmetry then results from the propagation time of the Alfvén wave and the bending of the magnetic field (Alfvén wing) along this trajectory. The ray paths of the decametric radiation are calculated using a three-disansional ray tracing program in the Jovian ionosphere. Variations in the expected probability plots are computed for two codels of the Levian ionosphere and global magnetic field, as well as for several choices of the ratio of the radiated frequency to the Louism to untoff frequency. The dependence of the courrence probability on the Jovian declination of the Earth is also discussed in the contest of this model. Jupiter, decametric radiation, Io, ray tracing).

J. Geophys. Res., Blus, Paper JA0031 J. Geophys. Res. Blue, Paper 3A0031

Physical Properties of Rocks

SISMIC VELOCITY AND ATTENUATION IN SANDSTONE AT ELEVATED TEMPERATURES AND PRESSURES

T. D. Jones and A. Nur (Rock Physics Proped, Repartment of Geophysics, Stanford University, Stanford, Ga P-305). New measurements of seismic velocity and attenuation have been made in the kilolieris frequency range to temperatures of 180°C, confining and pure pressure to 200 bers in Beres sandstone. With increasing temperature, shear velocity and attenuation decrease at all pressures in a fully saturated rock. The data suggest that thornal relaxation is not a significant less mechanism under these conditions. We propose that dissipation is controlled by a viscous dud flow mechanism, in which a sizer frequency peak in attenuation is shirted from 28th at room temperature to 8 kNs at 120°C as the pore fluid viscouity is decreased with increasing temperature. However, the velocity decrease is too great to be accounted for by a change of relexation times. A non-dispersive temperature softening in shear may control the velocities. (Seismic attenuation, temperature dependence, viscous flow).

Secophys. Sec. Lett., Paper 31,0047

Geophys. Res. Lett., Paper 31,0047

6110 Elasticity
VELUCITY AND AFFERNATION ANISOTROPY IN DEEP-GEA
CARRONATE SEDIMENTS
D. C. Kim (Easmit Institute of Geophysics, University of Hawaii, Emolulu, Rawaii 96822). K. W. Entabara,
M. H. Punghami and S. O. Schlanger
Laboratory studies have been carried out to determine the causes of velocity and attenuation emiscropy in palagic carbonate sediments from DEEP Size 288 on the Ontong-Seva Plateau. Compressional velocity (Vg)
massurements were carried out under independently—
controlled pore prassure and confining pressure.
Valocity a minutropy for compressional vaves (borisontal valocity anisatopy for pressure—i.e., with closure of pores. Previous scudies have suggested that valocity anisatory in palagic carbonate sequences is due largaly to preferred vertical orientation of colicis o-axes.
The pressur results indicate that preferred horizontal primatation of grain contacts and flat pores is also significant cause of the observed suiporropy for many smaples. Significant anisotropy in ultrasonic attenuation for compressional (Q-) and shear (Q-) were in the best of the contacts are described and contacts of the possible machanisms of description. (Resp. mass carbonates see sealers) or isontal grain contacts or flat horizontal pores.
The results are discussed in terms of the possible machanisms of discipation, (Resp. mas carbonates, pores, valority, ettenuation, anisotropy.)
J. Geophys. Res. Med Res. 2010.

6560 Metaoritics

DO GBLIQUE IMPACTS PRODUCE MARTIAN METEORITES?

L. E. Byguist (SM7, Geochemistry Branch, MASA, Johnson Space Center, Moustan, TX 77088)

Geochromological and geochemical characteristics of several achomoritic meteorites such those expected of Martian cots. Several authors have suggested that these meteorites might have originated on Mars, but no matisfactory explanation has been given of how they may have been queed from the Martian surface. It is suggested that the oblique impact of large meteoroids may produce ejecta which is entrained with the ricochating projectile and accelerated to valocties in maxams of Martian escape valocity. This suggestion is based on marifer experimental studies of oblique impacts and on the observation of several large Martian craters with the characteristic "butterfry ejects pattern produced by low augle impacts. Several accelerated to experized and fluid dynamic dreg should act an extern which the ricochating projectile should be experized and fluid dynamic dreg should act an extern dealized representation of ricochat and explosion of the projectile. It is shown that large ejects fragments, on the order of 1-10 percent of the initial projectile races of the Martian accelerated to valocities in excess of the Martian escape valocity. Pregnents greater than or equal to about a meter in size will excess the Martian escape valocity. Impact supple of langching sizable ejects are imported to occur at a maximum rate of about and acceptant of the comparable or love rate appendiction of potential Martian material escape on the soon. The long transit time between Hars and earth would lead to estable should be fired and acceptant of the soon. The long transit time between Hars and earth would lead to estable should be referred to report the state of the soon of the state and earth would cause any quara ejects to soon the safety to service in comparity of language and the comparable of a steady state population of potential Martian expensions.

the absence of lunar meteorites from our collection could be a simple observational affect due to the short torrestriel lifetime of meteorites. These considerations are preliminary in the same that several simplifications and assumptions are made. However, they suggest that a Rartian origin of the shergottice meteorites is dynamically possible. [Shergottice meteorites is dynamically possible. J. Goophys. Res., Red. Paper 281700

Seismology

6510 Atmospheres of planets
ATORIC CAYORN ENTRSIONS OBSREVED FROM PLONEER VENUS
R. R. Meier (F. O. Bulburt Center for Space Posenrch,
Haval Research Laboratory, Code 4140, Reshington, DC
20375), D. E. Anderson, Jr. and A. I. F. Stewart
Atomic caygen features at 1304 and 1336 A decacted
by the Orbiting Ultraviolet Spectroster (OUVS) on Piomour Venus are compared to theoretical emission models.
Lirb manus from three orbits of the Ol 1304 A existing
were smally used unite an improved model which researchs 6920 Employ Com Seismology Three Diverbional Crust and Upper Martle Strocture At the Newada Test Sites Stevan R. Taylor (Earth Bc(entes Department, Levrance Livermore National Laboratory, University of Galikornia, Livermore, California, 94550) The chres-disemstonal crust and upper meatic California, Livercore California, QASJO)

The threa-disensional crust and upper mantle structure at the WTS is derived by combining telessizate P-wave travel-time reactions with Possure time terms. The WTS is feares and relative telessizate P-wave travel-time reactions with Possure time terms. The WTS time terms and relative telessizate residents are calculated by treating the asplosions as a network of 'receivers' which record 'shoes' toested at the surrounding stations.

Utilization of the Pu fine terms allows for batter crustal resolution than in possible from telescimals information alone. Average relative telessizate P wave readdeds show a consistent progression of positive (late arrivals) to magative tesiduals from east to west across the WTS. However, Pu time terms beneath Espirer News are at least 0.3 and 0.5 seconds less than thous beneath Pahote Hese and Yucce Flat, respectively, indicating the presumes of high valuelty crustal material or crustal thinsing beneath Rainier Mese. The time terms show a slight correlation with the working-point valuelty at the shot point for Pahote Hese and Yucce Flat the Threa-disensional inversion of the travel later are decreased to residuals are observed laters! warraitones are caused by shallow affects of the upper crust.

Threa-disensional inversion of the travel time residuals augusts that Yucce Flat is cheracterised by low welocity are madely extending through the crust and into the upper mantle. Balatively low welocities are observed in the lower crust beneath the Tueth House hy arising calders south of Pahuta Hese observed differences in velocity mentle. These observed the friend-Houselin culture south of Pahuta Hese observed differences in the upper mentle. These observed time temper to make Houseling calders south of Fahuta Hese observed time theory or related to their magne Observed in medical mesent has inches the major appearance in the south of Pahuta Hese observed differences in velocity mentle. These observed differences in velocity mentle of the profess were smallyand using an improved model which recoves the restrictive assusptions of complete frequency redistribution and Lauthernal multiple scattering. Determedel comparisons indicate the Of 1304 A exission rates comparisons indicate the OI 1304 A emission rates observed are consistent with an O density 407 of the BUS model. It is elso found that the emission at 1356 A is consistent with the sum of the CO fourth positive bend at 1372 A and the D1 doubler at 1356, 1358 A; if an O density equal to 40% of the BUS model is used to calculate the OI emission rate.

6575 General (The Grust of Venus) THEORETICAL MODELS OF CHEMICAL AND MINERAL COMPOSITION

frictional heating was not lowered by the presence of water, lisat generated during deformation of a 0.13-cm-thick layer of simulated gauge was also measured for eliding rates from 0.09 to 9.1 us/s. In those gouge seperiments, temperature rises were less than 0.1°C and ware proportional to sliding rate. J. Geophys. Ros., Red, Paper 380025

Planetology

V.L.Barsukov (Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow, USSR), V. P. Volkov and I. L. Khodakovsky

Physico-chemical modelling of the atmosphe-ric-lithospheric interaction on Venus is presented. The thermodynamic aggessment is carried out in terms of Venera 11 and 12 and Pioneer Venus measurements and the dynamic atmospheric structure. The subcloud atmosphere is interpreted to be a some of nonequilibrium chamical conditions while the near-surface layer is presumed to be an equilibrium zone due to ostalytic effects *Work performed under the auspices of the U.S. Department of Energy by the Laurence Livermore National Laboratory under contract number U-7405-EM-58." J. Gmophys. Res., Red., Paper 281777 and low wind velocities. The mineral assemblages of the "weathering crust" are calculated. The pyrite-anhydrite-magnetite assemblage is suggested as the buffering system resulting in reducing conditions (PO,=10" atm). The existence of hydration 6950 SOISMIC SOURCES PROPERTIES OF SEISMIC MAYE SCATTERING AROUND WATER INJECTION WELL AT FENTON HILL HOT DRY ROCK GEOTHERMAL SITE is problematic and is thermodynamically conceivable only for the sulfur enrichment SITE

O. Mishizawa (Geological Survey of Japan, Geothermal Division, Ibrarui, Japan, C. Poarson, and J. Albright (Earth and Space Sciences Division, Los Alamos Mathonal Laboratory, Los Alamos, New Medico 87583)

To determine the scattering properties of microcracks created by water injection in not dry rock a mathod formallysing trajectory ellipsoids of seismic particle motions has been applied. Langths and directions of three principal axes of trajectory ellipsoids were calculated, and a distribution of the shape of these principal axes of trajectory ellipsoids were calculated, and a distribution of the shape of these of primary rocks (about 2 wt.%). The

theoretical models). J. Geophys. Res., Red, Paper 25!342

carbonate minerals are suggested to be

unstable. (Yezus, crust, mineral composition,

5075 Surface of planets
SHOCK TEMPERATURES OF SIO AND THEIR GEOPHYSICAL
IMPLICATIONS
C. A. Lyrange* and T. J. Ahrans (California Institute
of Technology, Pesadena, California, 91125) and
A. C. Mitchell (Lawrence Liversore Marional
Laboratory, Liversore, Ca 94550)
**anow at Jat Propulsion Laboratory, Fesadena,
California, 91109.
The temperature of \$10, in high pressures shock
states has been mesanted for samples of single crystal
acquarts and fused querta. Pressures between 60 and
140 GPa have been studied using projectis impact and
optical pyrometry techniques at Lawrence Liversore
National Laboratory. Both data sets indicate the
occurrence of a shock-induced phase transformation at
~70 and ~50 GPe slong the a- and fused querts
Hugoniote, respectively. The suggested identification
of this transformation is the molting of
maleing delayed by metastable superbeasing of the
crystalline phase. Some evidence for this transiction
in conventional shock wave equatten of state data is
given, and when these data are combined with the shock
temperature data, it is possible to construct the
stimbovite-liquid phase boundaries. The malting
temperature of stichnotice near 70 GPe pressure is
found to be 4500 K, and malting in this vicinity is
accompanied by a relative volume change and latent
heat of fusion of ~1.72 and ~2.4 MJ/Rg, respectively.
The solid stimbovite Eugenict cantered on acquarta is
well described by the linear shock velocity-particle
velocity relation, u = 1.822 u + 1.370 km/s, while
at pressures above the selling transition, the
Hugonict cantered on acquarts has been fit with u₀ =
1.619 u + 2.049 km/s up to a pressure of ~200 GPs.
The whiting temperature of stimbovite near 100 GPs
suggests a rough limit of 3300 K for the selling
temperature of 910.—bearing acide unpits admendia
assemblages, sli of which are believed to contain \$1.74
in octahedral toordination with 0.72. Thus 3500 K is
proposed as an approximate upper limit to the malting
point and the actual temperature in the acutal
is not the selling point 6800 Selemie sources TRIPLE SEISMIC ZONE AND RECIONAL VARIATION OF SEISMICITY ALONG THE NORTHERN KONSHU ARC H. Kawakutsu and T. Seno (Department of Geophysics, Stanford University, Stanford, CA 94500) Stanford University, Stanford, CA 94308)
The regional variation of seismicity along the northern Honsbu and, Ispan, is studied using account focal depids and fonal mechanism type. We use the focal depids and fonal mechanism type. We use the focal depids attending for pP-P lime intervals reported in the ISC bulletins. For submarine carthquakor, depths are corrected by considering the pP-phase reported in the bulletins as the psP-phase (the redection from the cocan surface). Out of more than 600 well-located earthquakes which are selected from the ISC bulletins, we determine the types of the focal machanisms of 184 avents using P-wave first motion data.

Resed on historical seismicity of great and large from the 18C building, we determine the types of the terms menhanisms of 184 events using P-wave first motion data. Based on historical setsmicity of great and large earthquakes, we divide the tone of throat type sertiquakes at the place into two regions; the shellow thrust rone (0-40km), where great sertiquakes (2-3.0) occur and the deep thrust sone (40-60km), where large (2-7.4) satthquakes occur. The solvity of great or large sertiquakes shows a varietion slong the arc; in some regions, both the shellow and deep thrust sones are notice and in other regions, one or the other of the thrust zones is solve.

and in other regions, one or the other of the threst somes in solly.

The seismicity of reasont moderate size earthquakes (May 4) combined with the focal mechanism type shows a vertetion along the are which is in amount with the variation of the sollvity of great or large actiquates. Where large sertiquates where large certiquates do not occur in the deep thrust zone, not the threst type nor down-dip nompression/tension type event cour in and beneath the deep thrust zone, was find a number of thrust type sortiquates. Further, in the latter case, in some regions, the down-dip compression and tension type events of the down-dip compression and tension type events of the down-dip compression and representation to the double seized some attendessward just herseth the deep thrust gone and form a triple-placed structure of retained ty (the triple seizemic sone). This study confirms the hypothesis of previous workers (Seno and Pongaswal, 1981) on the causal relation between the strong seizemic coupling of two converging plates at the deep thrust zone and the extension of double scientic sone; i.e., the presence or absence of activity within the slab beneath the deep seized zone acoust when the deep thrust zone has a strong or weak coupling, respectively. Here, the week coupling could be laterpreted as either specimes by our size should stirt the last

respectively. Here, the week coupling could be taterreted as either a selsmin sing or as low stress buildup after the last large event cocurred at the deep threat zone.

Triple selsmid zones are found offshore of Myagi projectors, where the deep threat sone has been broken recently in 1978 and offshore of Fukushina Prefecture. We expect a butter large earthquake at the deep threat zone offshore of Fukushima prefecture because the presence of the triple selsmin zone suggests atrees has been accommissing and 40 years here passed since the deep threat zone was reptured in 1935.

categrated, and a distribution of the shops of the ellipsonis bugusts elistence at a strong Scattering region around the injection point. Inis strong scattering has an anisotropic property presumably due to microcrack orientation in the original root Geophys. Res. Latt., Paper 2L1472

6930 Seisele Sources
A TELESCIPIC ANALYSIS OF THE SEM BRUNSWICK EASTHQUAKE
OF JABRARY 9, 1982
G. L. Choy (U.S. Geological Survey, Ecx 25046, ME 967,
DPC, Derver, OB 6225), J. Boatwright, J. N. Dewey
and S. Sipkin
The analysis of the New Brunswick earthquake of
January 9, 1982 has important implications for the
avaluation of seiseic bearris in mastern Morth America.
Although moderate in size (s. 5.7), it was wallrecorded takesismically. Source obspacetations for the
avaluation of seiseic bearris in mastern Morth America.
Although moderate in size (s. 5.7), it was wallrecorded takesismically. Source obspacets lates of
this aerthquake bive been determined from analysis of
description of the repture produce as wall as conventional station properties of I has source. The depth of
the hyponenter is estimated to be 9 in from depth
phates. The fousk mechanism determined from the
broadband data corresponds to predestinantly thrist
faulting, Prom the variation in the investors the
direction of the site is infarred to be undin on a
west-dispine MHE-artiking Fault plane. The stebp dip
of the signared fault plane suggests that the hearthquels optured on a prescripting Fault that was at one
time is normal fault. From an investing of body-leave
piles dorations, the actions of this tuptor's process water
mainted by a memont tensor analysis of long-period 7

and SE body waves. The long-pariod moment of this certhquake was 5.7x10²⁴ dyno-cm. The static and dynamic atrees draps are 45 and 75 bare, respectively, similar to those of many certhquakes with similar moment in regions that are more following light epicenter decomination (JED) algorithm was used to locate, relative to the mainshock, the three telessistically recorded aftershocks that occurred through March 31, 1982. The relocated hypomenters of the aftershocks are significantly different from each other and from that of the mainshock; they provide additional support for the source dimensions inferred from the waveform analysis.

1. Goophys. Res., Red. Paper 281952

6930 Soiente Sources
FOCAL DEPTHS AND FABLT PLAME SOLUTIONS OF EARTHQUARES UNDER THE TIBETAN PLATEAU
P. Holmar (Department of Earth and Planetary Sciences,
Kassachusetts institute of Technology, Cambridge, HA
02139), and M.-P. Chen
We coupere synthetic and recorded P wave forms to
place constraints on the focal dopths and fault plane
solutions of 16 crustal sarchquakes beneath the highest
parts (-4000 m) of the Tibetan plateeu. Fault plane
solutions for all 16 events show combinations of normal
and strike slip faulting with T same oriented approxitantely dest-west. None of these solutions show thrust
featiting. Thus the date corrobacets provious inferences that the scrive tectonics are dominated by seat-west
extension. Focal depths for all 16 events are lose
than 15 hm and appear to be abtween 3 and 10 km. This
style of deformation and times depths of familing are
similar to those in the Samin and Range province of the
venters United States. Two intermediate depth cents
below the crust of southern Tiber also show primarily
normal faulting with onst-west T axes. The salution
for end, discussed by Chen et al. (1981), is unambiguous. The solution for the other, the event of August
1, 1973 (27.59°M, 89.17°E, 85±10 km, n. = 4.9) is less
cortain. Seth apparently occurred in the mantle beneath
a thick, assistate lower crust, and their occurrence
suggests that britcle deformation occurs there in
response to a stream field sinilar to that operating
at shallow depths beneath Tibet. (Focal depths, Tibet,
earthquakes).
J. Geophys. Fas., Red, Paper 281712

6950 Selsuic source VIECOGIASTIC STRESS RELAXATION ON DEEP FAULT SECTIONS AS A POSSIBLE SOURCE OF VERY LONG-PERIOD ELASTIC WAVES . Bonalede, E. Boschi and K. Dragoni (Istituto

di Geofisica, Università di Bologna, Via Irneria

di Geofisica, Università di Bologna, Via Irnerio 46, 40126 Bologna, Italy) Observations of very Long-period elastic waves are attributed to 'milent' sarthquakes, owents which are presumed to occur at depth in a uon-brittle regime. The fault at depth is modeled as a thin plastic-viscoelastic gouge layer exhaded in an elastic medium. The source of allent earthqueves is envisaged as a prolonged, slow slippage of the fault faces, which yields a far-field radistion spectrum strongly depicted in the bigh-frequency components, the results of the model compare favourably with the dominant frequencies tien recorded at Tricage in the years preceding the 1976 Friul (Italy) earthquake . The rol that silent coarthquakes may play in the overall earthquake mechanism (in particular as precursor henomena) is discussed. (Silent ears fault gouge theology, procursory phenomena).

6950 Seissic Sources
KIMENTIC ANALYSIS OF STRONG HOTION P AND SV VAVES
FROM THE STERLING EVENT
C.A. Langeron, Department of Geosciences, 440 Dethe
Building, The Pannsylvania Sterm University
Park, 74 16502
P and 5V velocity wave forms from the Sterling
explosion of 3 December 1955 are analyzed from a
point of view often taken in earthquake source
studies. The detomation occurred in the casity
excavated by the Selmon explosion within the Tatum
sait dome, Hississippi. Valocity recordings taken
from nestry borebale strong motion instruments show
the occurrence of significant SV manety (Perret,
1965). Thomsatic source models are constructed by
considering constraints afforded by the preshot
cavity, condition of the surrounding material, and
aspects of the P and SV wave forms such as wave
polarity and duration. Nave forms for these module
are competed and compared directly with the data.
Modeling results suggest that the SV waves were
radisted primarily by induced normal faulting
occurring beneath the cavity rather than by an
expensetic pressure distribution based on the grambot
cavity goomstry. Secondary arrivals within the P
wave (orms and SV supitudes suggest that these
normal faults also had a companet of tensional
displacement which was probably due to forceable
injection of material from the blast. A measurement
for 0g of 35 is obtained for ealt from the amplitude
decay and pulse with changes observed for SV waves
along a profile taken at shot laval. This value for
Og is for the region away from the cracked eres
induced by the previous Balmon explosion and
qualitatively explains the differing frequency
occurate observed at the alonest Starling sensors
between P and SV waves. The anomalous SV radiation
has lifet to do with 'tectonia' stress release but
is a result of the medium's geometry and anisotropy.
J. Geophys. Res., Ed., Paper 281957

8970 Structure of the Grust and Upper Mantle THE GODIO, BRAIL-SCALE CONVECTION, AND DIFFERENTIAL TRAYEL TIME ANOMALIES OF SHEAR MAYES IN THE CRETIAL INDIAN OCEAN Nitchel Stark (Department of Guological Sciences, Brown University, Froyldence, RI 02912), Donald M

From Daivarsity, Providence, RI 02912), Consid M. Forsyth

Fe have measured 37 differential travel times for the place pairs 88-8, m85-25, 825-25, 825-36, 825-86, 825

in the Contral Mains Banin in 2,800.7 m (famt). This contrasts with 44.2 m (alony) reported for the western Pacific by Siykis and Jorden, and is mimilar to the -4.0 m found for old continguish suckets. After correcting for known differences between continguish, and oceanic crustal etweburs and for differences in measurement technique, we find that trayed time; in the mantis beneath the Contral Indian Basin are midday in character between those beneath pre-Cambrien mideldend them to be mental the western Facilies Gests heales. The reggesting that the source of the good amounty may also be largely responsible for the difference between the Control Indian and Facific besine.

The Chapes-Lacedive lidge seems to covacide with a transition from the fact differential travel classe of

the Crairel Indian Beais to elever differential travel times sensatable with betwee points beamath young sea floor char sective spreading capthra. There are also exclusions within the fantral Indian Basis which are not related to explace geological features or to the age of the sea licor. These variations are periodic with a wavelength of about 400 has med with a pint trend, which agues approximately with the trand which would be superted for linear, conventive fulls in the upper mantle. (Boold, convention, travel times). J., Geophys. Rew., Red., Paper 281960

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